DOCUMENT RESUME

ED 205 346 RC 012 863

AUTHOR Boules, Allen, Ed.
TITLE Outdoor Education: Issues & Investigations, 5-8.
INSTITUTION Oklahoma State Dept. of Education, Oklahoma City.
PUB DATE 81
NOTE 262p.

EDRS PRICE MF01/PC11 Plus Postage.
DESCRIPTORS Educational Games; Elementary Education; Energy; *Environmental Education; Geology; *Instructional Materials; *Learning Activities; Natural Resources; *Observational Learning; Outdoor Activities; *Outdoor Education; Program Evaluation; Recreational Activities; Recreational Facilities; *Resource Units; Vocabulary Development; Water Resources
IDENTIFIERS *Oklahoma

ABSTRACT

Designed to familiarize Oklahoma students with their environment by providing opportunities for exploration, investigation, and evaluation, this outdoor education guide contains suggested activities to be used as a starting point to arouse the interest and curiosity of students through direct observation and investigation. As an additional teaching aid, science-related words which may be new to a student's vocabulary have been underscored and are followed by a guide to pronunciation. Chapter 1 describes the geology and natural history of Oklahoma. Chapter 2 discusses Oklahoma's water resources. Chapter 3 identifies the state's recreational facilities. Chapter 4 discusses energy consumption and conservation. Chapter 5 describes various aspects of environmental health. The activity sections of each chapter state the concept to be taught, the purpose of teaching the concept, instructional materials to be used, teaching procedure, and questions to consider. Appendixes include a glossary of scientific words, teacher aids, an annotated list of films and filmstrips, a list of references and resources, and an evaluation sheet to be completed by teachers. (CM)

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OUTDOOR EDUCATION

Issues & Investigations

1981

Oklahoma State Department of Education

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Foreword

The Oklahoma State Department of Education recognizes that outdoor education has become an essential part of the science program in our schools. The outdoor classroom should be considered as an extension of the indoor classroom where students as well as teachers can learn through the process of discovery and investigation.

We hope that information contained herein will be of help to teachers making the transition to outdoor education.

We wish to thank the following agencies and organizations for their provision of financial aid and technical assistance in the publication of this book:

Oklahoma Conservation Commission	Leonard A. Solomon, Executive Director
Department of Mines	Jim Shirazi, Director
Department of Pollution Control	L.R. Edmison, Director
Oklahoma Department of Tourism and Recreation	Abe L. Hesser, Executive Director
Oklahoma Water Resources Board	Jim Barnett, Executive Director
Oklahoma Curriculum Improvement Commission	

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Introduction

This study guide is designed to familiarize the students with their environment by providing opportunities for exploration, investigation, and evaluation. As students become more informed about their surroundings, they will also become more thoughtful, concerned, and creative members of society.

Each student should be encouraged to expand his knowledge in a variety of ways. Demonstrations, discussions, painting, modeling, and story telling will help the student understand the concept, and, at the same time, enable the teacher to evaluate each student's progress. Suggestions are given for a variety of media and techniques, such as experiments, creative or dramatic play, field trips, etc. The results of these activities also provide the teacher with a means of evaluation.

The suggested activities are a starting point designed to arouse the interest and curiosity of the student through direct observation and investigation. In some cases, several activities have been included to support the same concept. The teacher should select the ones determined to be most beneficial for the grade level being taught, then use the remainder as either reinforcement or enrichment teaching aids. It is also expected that teachers, as well as students, will develop additional activities that are suitable for their particular area and scope of interest. When examining these activities, exercise your judgment in modifying the materials, procedures, or sequence of events. Remember that science is a system of natural phenomena.

As an additional teaching aid, science-related words which may be

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new to the student's vocabulary have been underscored and are followed by a guide to pronounciation. A glossary is included in the appendix. Students should be encouraged to include these words in their vocabulary as they become more familiar with the content of this Outdoor Education Guide.

Acknowledgements

Mr. John Folks
Executive Director of Instruction
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Mr. Leonard Bates
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Special thanks to the administrators of the following school systems who allowed staff members to participate on this development committee.

Ardmore Public Schools
Bacone College, Muskogee
Edmond Public Schools
Ft. Towson Public Schools
Norman Public Schools
Okemah Public Schools
Oklahoma City Public Schools
Okmulgee Public Schools
Pryor Public Schools
Shawnee Public Schools
Tishomingo Public Schools
Tulsa Public Schools

Thanks also to the administrators of the following agencies whose personnel participated on this committee:

Department of Pollution Control
Oklahoma Conservation Commission
Department of Tourism and Recreation

Credits

These educators participated in the planning and writing of this handbook and deserve a sincere expression of appreciation.

Jane Bell
Oklahoma City Public Schools

Richard Bryant
Okmulgee Public Schools

Sid Caperton
Tishomingo Public Schools

Gary Cook
Shawnee Public Schools

Rosemary Eskridge
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Dr. Doris Grigsby
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Ft. Towson Public Schools

Jocelyn Markley
Ardmore Public Schools

Dr. Larry McKinney
Okemah Public Schools

Tim O'Halloran
Tulsa Public Schools

Alicia Osborne
Pryor Public Schools

Bud Osborne
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Oklahoma Symbols

STATE SEAL:	Centered by a five-pointed star bearing a three-figured symbol of the Frontiersman, the Indian, and "Justice," the state motto and other symbols, all surrounded by 45 smaller stars.
STATE MOTTO:	The Latin, "Labor Omnia Vincit," meaning "Labor Conquers All Things."
STATE FLAG:	An Osage warrior's shield in a field of blue with the shield crossed by a peace pipe and olive branch.
STATE SONG:	"Oklahoma" from the Rodgers and Hammerstein musical of the same name.
STATE FLORAL EMBLEM:	Mistletoe
STATE TREE:	Redbud
STATE BIRD:	Scissor-tailed Flycatcher
STATE GRASS:	Indian Grass
STATE REPTILE:	Mountain Boomer or Collared Lizard
STATE ROCK:	Barite Rose Rock
STATE FISH:	White Bass or Sand Bass
STATE ANIMAL:	American Buffalo (Bison)

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THE NATURAL HERITAGE OF

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CHAPTER 1

THE NATURAL HERITAGE OF OKLAHOMA

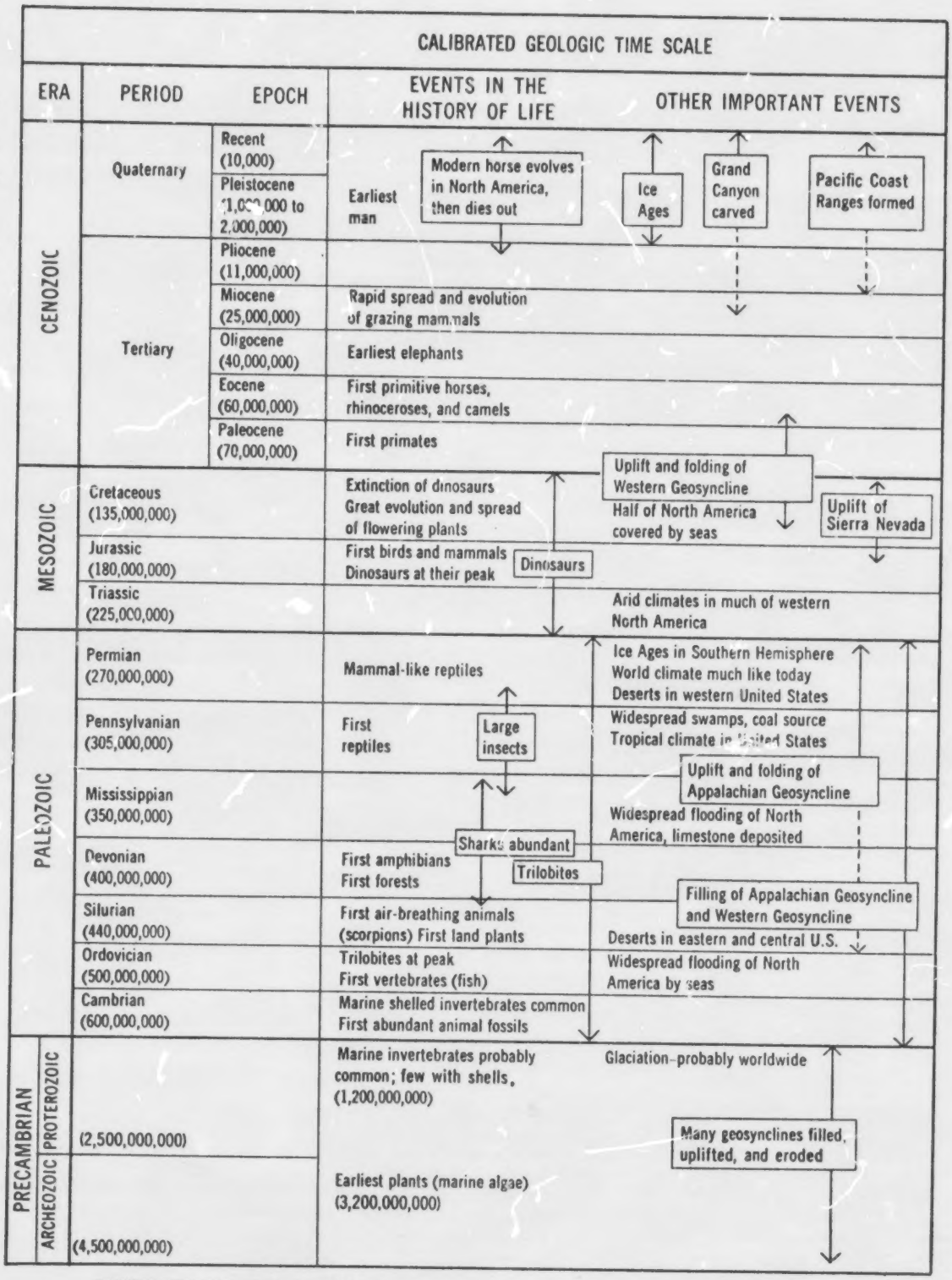
To study the earth as a whole, or any part of it such as our own State of Oklahoma, we need first of all to understand how and when it was formed.

The term geo (ge'-o) - is a root word meaning earth, ground, or soil. So when we refer to geological time, for example, we mean the long period of time that deals with the earth's history. Geological time is expressed by a "Geological Time Scale" (see Figures 1, 2, and 3). Major divisions of geological time are called eras (air'-ahs), and smaller units are periods (per'-e-ids) and epochs (ep'-iks). Geography is a science that investigates the natural features of the earth and its climate, products, and inhabitants.

Now, let's investigate Oklahoma's Geological Heritage.

Since the beginning of time, geological processes have been shaping the earth, forming rocks, minerals, and all the familiar resources.

The first chapter in the geologic history of Oklahoma was the formation of the Precambrian (Pree-kam'-bree-ahn) granites and other rocks from molten, volcanic material. These rocks can be seen in the Arbuckle and Wichita Mountains, and extend under the surface throughout the state as a "basement rock" on which all of the "younger" rocks rest. The oldest granites are in the Arbuckle Mountains near Tishomingo, and are about 1.35 billion years old.



NUMBERS REFER TO TIME IN YEARS B.P. (BEFORE PRESENT) SINCE THE BEGINNING OF THE ERA, PERIOD, OR EPOCH

Figure 1

GEOLOGIC TIME CHART

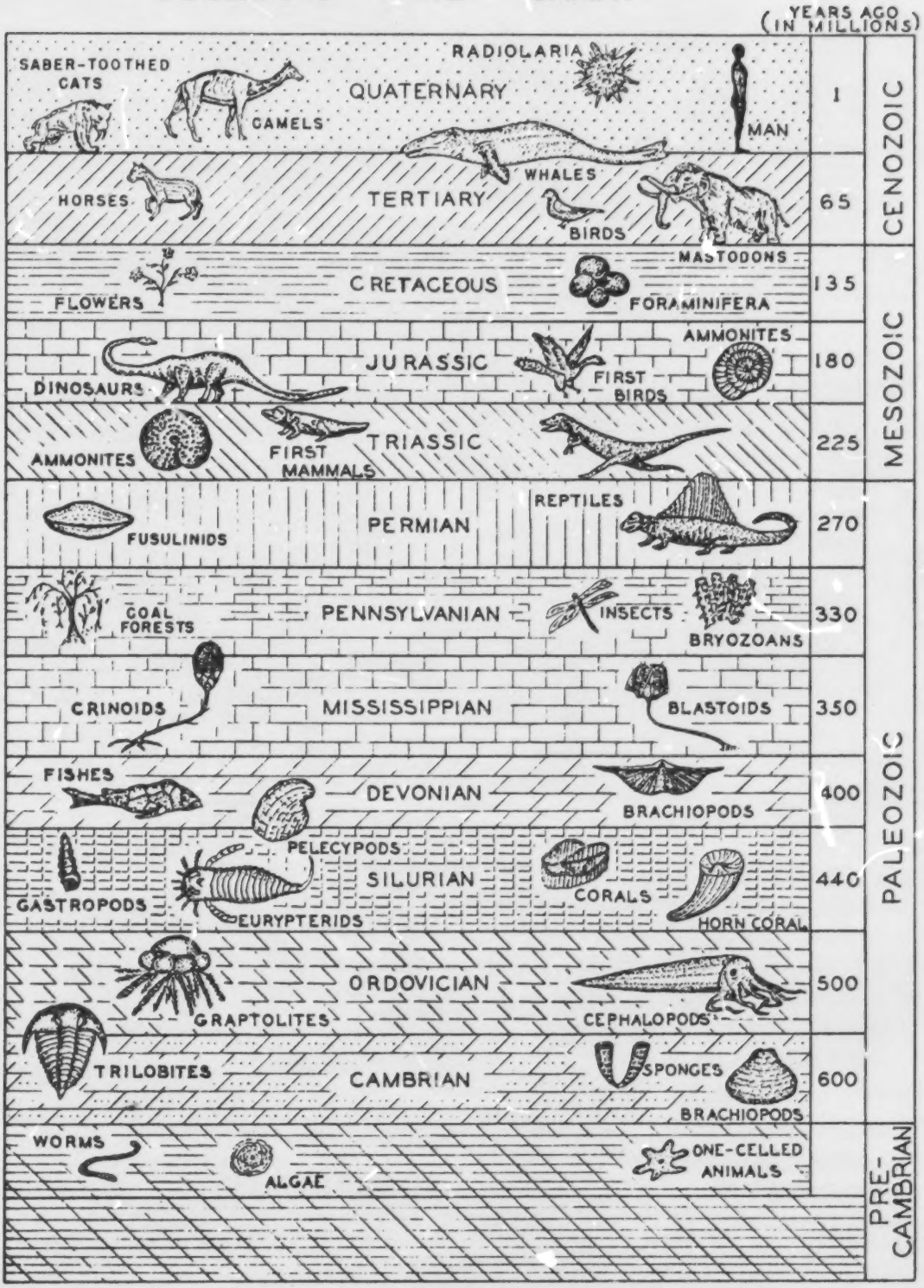


Figure 2

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GEOLOGIC TIME SCALE COMPARED TO A CALENDER YEAR

Geologic Era	Geologic Period	Beginning (1,000,000 years ago)	Comparative Date Day Hr. Min.
CENOZOIC ("recent life")	Quaternary	1	December 31 22 03
	Tertiary	70	December 26 7 44
MESOZOIC ("middle life")	Cretaceous	135	December 21 1 12
	Jurassic	180	December 17 9 36
	Triassic	220	December 14 3 44
PALEOZOIC ("ancient life")	Permian	270	December 10 2 24
	Pennsylvanian	320	December 6 1 04
	Mississippian	350	December 3 14 40
	Devonian	400	November 29 13 20
	Silurian	430	November 27 2 56
	Ordovician	490	November 22 4 37
	Cambrian	600	November 13 16 00
PRECAMBRIAN		4,500	January 1 0 00

16

Figure 3

Beginning in late Cambrian (Kam'-bree-ahn) time (500 million years ago) and continuing through the end of the Mesozoic (Mez-ah-zoh'-ik) era, large areas of the state were submerged periodically by huge inland seas. Thick layers of sand, clay, lime, and mud settled to the bottom of these seas and were later consolidated into sandstone, limestone, and shale with a total thickness of about 40,000 feet. During this time there were short periods when the seas receded to leave large areas of the land exposed.

Now, if you have looked at the Geological Time Scale (Figures 1, 2, and 3), you know that during the Precambrian era the only living things on earth were plants such as algae (al'-ge) and marine invertebrates (in-ver'-tah-brates), which are worms, corals, jellyfish, etc. During the Cambrian period, starfish, snails, sponges, brachiopods (brak'-e-o pods), and trilobites (try'-lah-biets) were added. These animals and plants left their shells and imprints preserved in the rocks as fossils and can be found in many parts of Oklahoma today.

During the late Paleozoic (Pay-lee-ah-zoh'-ik) era, there was a tremendous pressure underground, which resulted in a great uplift that formed the Wichita, Arbuckle, and Ouachita Mountains. The thick, sedimentary (sed-a-men'-tree) layers that had been deposited nearly horizontally in the inland seas were now uplifted, folded, faulted, and eroded, exposing older rocks underneath and, in turn, forming new deposits.

The rocks of the Paleozoic era contain the oil, gas, coal, and other mineral deposits that are economically important to Oklahoma. These rocks crop out over about 75 percent of the state and are covered by

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Minerals of Oklahoma

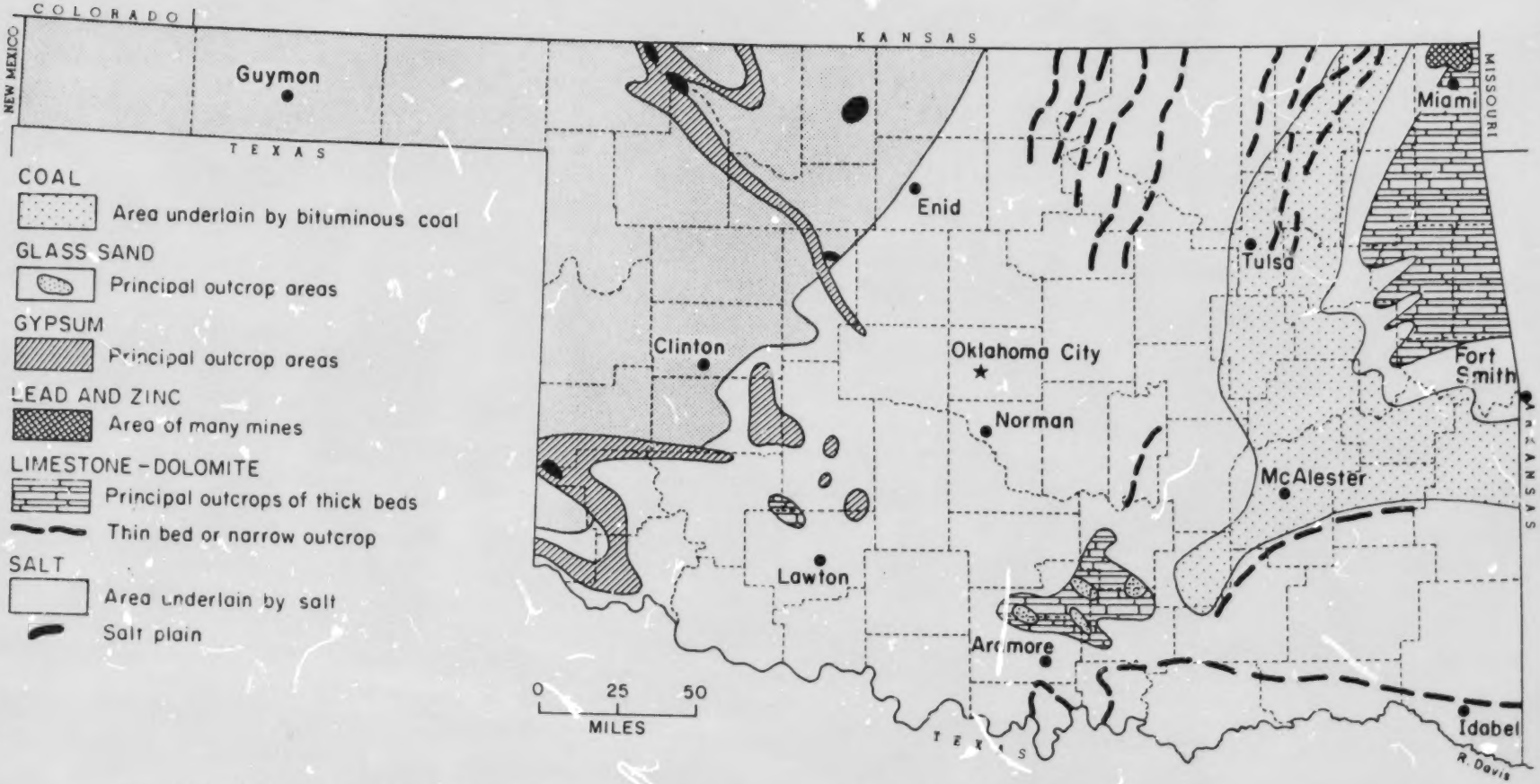


Figure 4

Map information compiled by Dr. Kenneth S. Johnson for the Oklahoma Geological Survey, Dr. Charles J. Mankin, Director.

younger deposits in the other 25 percent of our land (Figure 4).

NOTE: When you looked up the Paleozoic era on the Geological Time Scale did you notice that during this time many new forms of life appeared on earth, such as spiders, scorpions, large insects, dragonflies, cockroaches, centipedes, reptiles, and sharks? During the Mesozoic era (135 to 225 million years ago), we find evidence of the existance of dinosaurs, marine and flying reptiles, and evergreen trees. Would you like to look for fossils of these early inhabitants of Oklahoma? If so, see Figure 5 for locations.

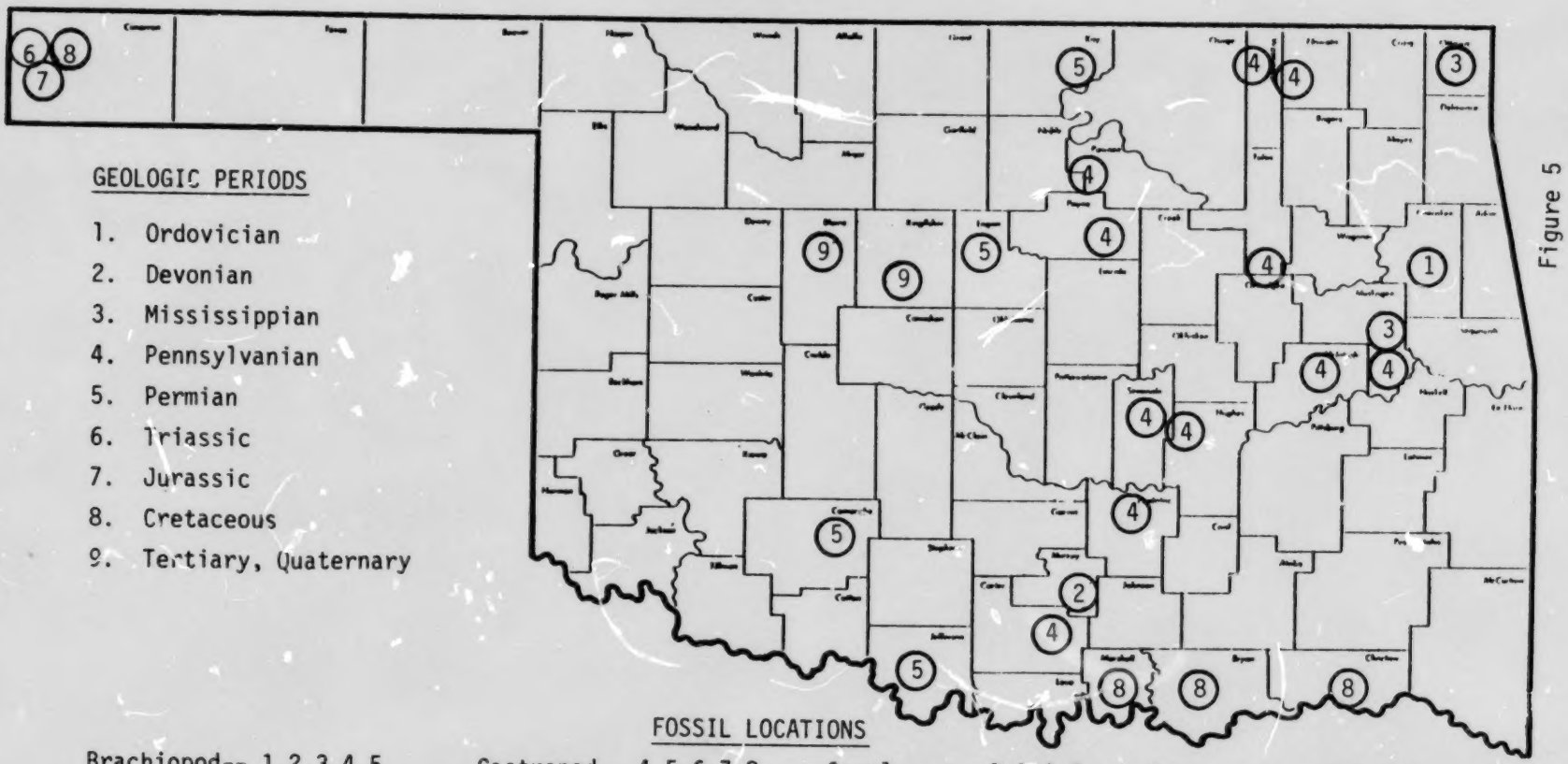
About 65 million years ago during the Cenozoic (Sen-a-zoh'-ik) era, a great uplift of Central North America formed the Rocky Mountains in Colorado and pushed the inland sea southeastward out of Oklahoma for the last time. Sediments laid down since that time are all land or fresh water deposits. Fossil bones of camels, elephants, horses, and sharks have been found in these sediments.

The many geological changes we have just discussed are responsible for some of the unique areas in Oklahoma. Alabaster Caverns, the Arbuckle Mountains, Black Mesa, Great Salt Plains, Quartz Mountains, Red Rock Canyon, and the Wichita Mountains are only a few of the interesting field trips you might take with your class (or with your family). Additional field trip information is in the appendix.

A study of rocks and minerals can be an introduction to the geological heritage of Oklahoma. To begin such a study, it would be interesting for your class to take some field trips to collect rock and mineral specimens.

The greatest variety of rocks and minerals are found in the Wichita

OKLAHOMA FOSSIL LOCATIONS ACCORDING TO GEOLOGIC FORMATIONS



GEOLOGIC PERIODS

1. Ordovician
2. Devonian
3. Mississippian
4. Pennsylvanian
5. Permian
6. Triassic
7. Jurassic
8. Cretaceous
9. Tertiary, Quaternary

FOSSIL LOCATIONS

Brachiopod-- 1,2,3,4,5	Gastropod-- 4,5,6,7,8	Coral------ 2,3,4,5	Bone-------- 6,7,8,9
Pelecypod--- 4,5,6,7,8,9	Crinoid---- 1,2,3,4,5	Bryozoa---- 1,2,3,4,5	Sea Urchin-- 8
Cephalopod - 6,7,8	Blastoid--- 3,4	Fusulina--- 4	Trilobite--- 2,3,4,5

Key: Fossils are cross-referenced to their geologic time periods.

Figure 5

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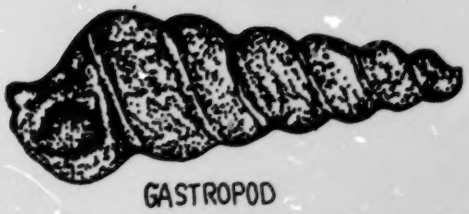
FOSSILS IN OKLAHOMA

BRACHIOPOD

BLASTOID



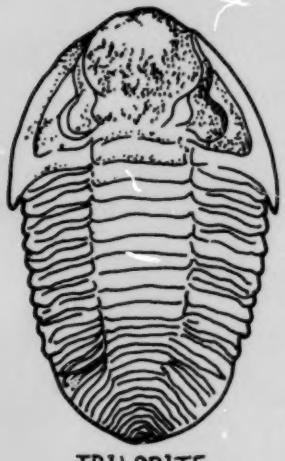
GASTROPOD

CEPHALOPOD

SEA URCHIN

PELECYPOD

SEA URCHIN



TRILOBITE

Figure 6

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and the Arbuckle Mountains. All areas of the state, however, have many different rocks, in many cases types that are unique to that area. Many creekbeds will yield a variety of rocks, some tumbled from as far away as the Rocky Mountains. As you gather your specimens, try to find several pieces of petrified wood to put into your collection.

Two of the most unusual rocks found in Oklahoma are the barite crystals, known as "rose rocks" (the official State Rock of Oklahoma), and the selenite (sell'-in-ite) crystals found at the Great Salt Plains (see Figures 7 and 8). NOTE TO TEACHER: Each student should try to get a specimen of each of these for his collection. You may want to write to the Oklahoma Geological Survey (see appendix for address) for additional information about the rocks and minerals available in your particular area of the state. Collecting rock, mineral, and fossil specimens will make the study of outdoor education more interesting for the student.

The distinctive rose rock concretions (kon-cree'-shuns), reddish-brown in color with a general similarity to a rose in full bloom, are petal-like clusters of sandy barite crystals. Their rose-like appearance is due to the growth of barite (barium sulfate, $BaSO_4$) as a cluster of divergent blades. The central Oklahoma rosettes are distinctive because they grew in an ancient red sandstone, incorporating quartz sand grains and acquiring the red color of the host rock. These concretions consist of sand and barite in nearly equal proportions and, thus, are best known to geologists as "sand-barite rosettes." They also are called "barite roses" or "petrified roses." Well-formed specimens are highly prized by collectors.

Most sand-barite rosettes are 1/2 to 4 inches in diameter and con-

sist of 5 to 20 radiating plates, although the largest known rosette is 17 inches across, 10 inches high, and weighs 125 pounds. They generally occur as isolated individuals scattered through sandstone. Rosettes are harder and more durable than the host rock and weather into positive relief on outcrops. On further weathering, they are detached from the rock and occur as individual specimens scattered within residual (ree-zid'-u-al) sandy soil.

The sand-barite rosettes of Oklahoma occur mostly in the Garber Sandstone, which was deposited during the Permian (Pur'-me-ahn) Period of geologic time about 250 million years ago. They are most abundant along the north-south outcrop of the Garber Sandstone in central Oklahoma, in a narrow belt extending 80 miles between Pauls Valley and Guthrie (see Figure 7). The area just east of Norman is particularly renowned for its abundant and well-formed specimens. Although also found in California, Kansas, and Egypt, the rosettes probably have a greater concentration in Oklahoma than any other place in the world.

(This description is mainly from the out-of-print article: Ham, W. E., and Merritt, C. A., 1944, "Barite in Oklahoma": Oklahoma Geological Survey, Circular 23, 42 pages, 2 figures, 4 plates.)

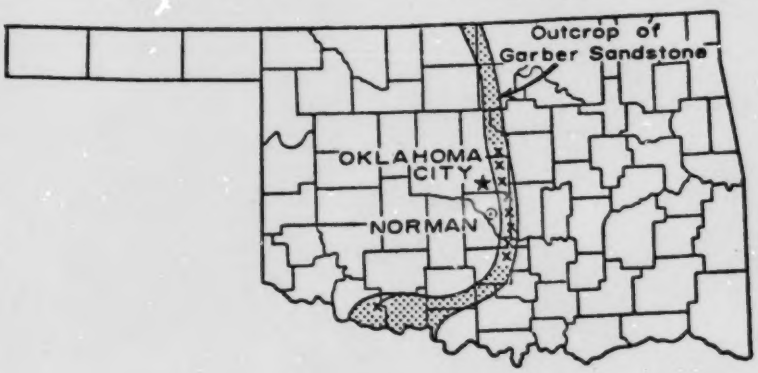


Figure 7

Rose Rocks
(barite crystals)

Selenite Crystals

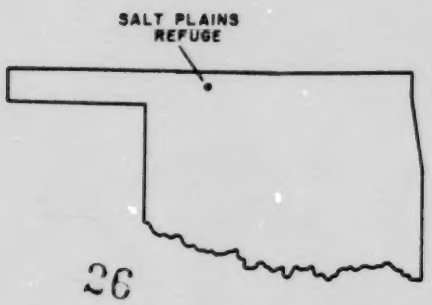


Figure 8

What is selenite? Selenite is a crystallized form of gypsum, which is a common mineral that takes on a great variety of forms and shapes. In Oklahoma on the Salt Plains (Figure 8), the crystals are formed just below the salt-encrusted surface. They are seldom deeper than two feet.

At certain places on the Salt Plains, gypsum and saline solutions in the soil are sufficiently concentrated to promote crystal growth. When temperatures and brine conditions are ideal, the crystals may form very rapidly. When heavy rains or floods bring great quantities of fresh water to the plains, some of the selenite crystals may go back into solution until conditions are again right for recrystallization.

Because these crystals form in wet soil, sand and clay particles are included within the crystal. The included particles often form a characteristic "hourglass" shape, which is found only in this area. The chocolate brown color is from the iron oxide in the soil. Other foreign objects in the soil, such as sticks, rocks, bones, and even cockleburrs, are occasionally embraced as the crystals form. Single crystals, penetration twins, and clusters are the typical crystal shapes. Exceptional individual crystals, as long as seven inches, are found here, as well as complex combinations of crystals weighing as much as 38 pounds.

The collection of selenite crystals on the Salt Plains National Wildlife Refuge is permitted from 8:00 A.M. to 5:00 P.M. on Saturdays, Sundays, and holidays only during the period from April 1 to October 15 of each year. No special permit from refuge headquarters is required for collecting the selenite crystals.

Collecting selenite crystals has become a fascinating activity for many visitors to the area. Students of geology, mineral clubs, and

natural science hobbyists are especially attracted to the area, as well as those with a natural curiosity of nature's wonders.

As long as nothing happens to change the mineral content of the waters draining into the Great Salt Plains, these crystals will continue to form.

Another interesting rock found in many parts of our state is a somewhat hollow rock, called Indian Paint Pot. Filled with a soft deposit of red or yellow iron ore, Indians used this for their war paint.

The Oklahoma Thunder Egg, another rock unique to Oklahoma, is a brick-red barite nodule with veins of calcite; some are full of sparkling calcite crystals. They can be found along the road cut on State Highway 177 near Warwick as well as a few other places in the state.

We use the rocks and minerals found in our state daily. You can see stone buildings, crushed rock on our highways, sand in cement, stone walls, and stone bridges. The salt on your table is the mineral halite (hay'-lite). The chalk you use at school is a soft-grained limestone. The blackboard is a metamorphic (met-ah-mor'-fik) (the word means "change") rock-slate. The linoleum on your kitchen floor is probably made from copalite (ko'-pah-lite), a resin found in rocks.

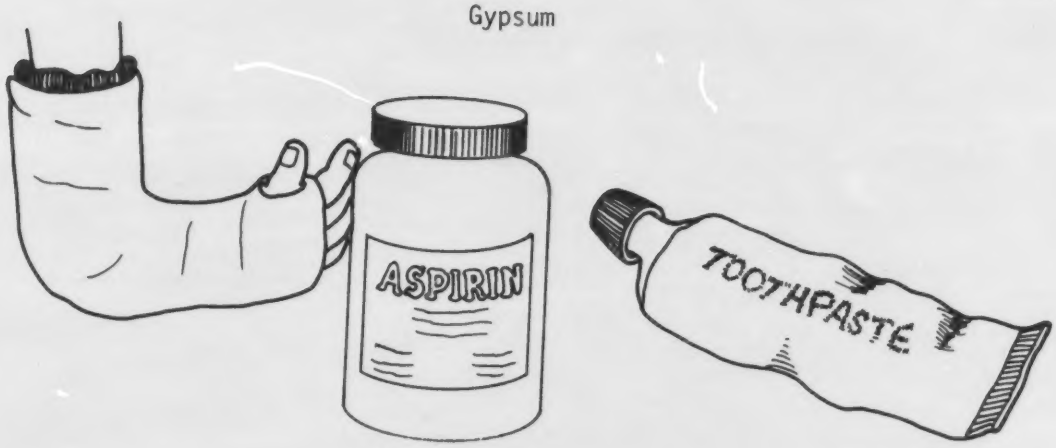
The "lead" in our pencils is made from the mineral graphite (graf'-ite). The oil for our cars comes from another mineral product, petroleum. Steel is made from iron.

One of the "rocks" found in our state is actually a mineral which is used by all of us in some way nearly every day of our lives. This mineral is gypsum. Have you ever had a broken arm or leg? Casts are made from gypsum. It is used as a filler in food products--everything

from cake mixes to the toothpaste you used this morning. The aspirin you take for a headache is mainly gypsum, as are vitamin capsules. As a "filler" it adds bulk to the small amount of medication required for a specific pill, capsule, etc., and we can therefore handle it easier.

The box of detergent used to wash your clothes contains a high percentage of gypsum, again as a filler for the product. So you can see that we do use rocks in many ways, every day of our lives.

Gypsum



When the first forms of life appeared in Oklahoma, so did the first ecosystem (ee'-ko-sis-tum). An ecosystem consists of the habitat (physical environment) and the biological community (all the interacting organisms) of an area.

Ecosystems change as their components change. These changes may occur as rapidly as diurnal (die-ur'-nal) cycles, more gradually as with seasonal fluctuation, over hundreds of years as with the life cycle of an oak tree, or over geologic time as with the formation and erosion of a mountain range.

Most plants and animals present today are very different from the organisms which lived 200 million years ago. The physical environment has also changed greatly. But, even though the components have changed, the ecosystems which existed then and the ones today are similar in structure and function. These similarities suggest that today's ecosystems evolved from those of the past, just as their physical and biotic (bi-ah'-tik) components have evolved from past forms. Our present ecosystems represent an ecological heritage to be studied, understood, and conserved. Without an appreciation of the past, we have no sense of direction in the present and cannot predict nor plan for the future. A study of Oklahoma's modern ecosystems must recognize the legacy they include.

Whether an ecosystem is a pond or a grassland, a forest or a stream, it has energy flowing through its components. In virtually all ecosystems the sun is the source of this energy. Through the process of photosynthesis (fo-toe-sin'-thee-sus), green plants are uniquely capable of converting sunlight into a form of chemical (food) energy, that can

be used by other organisms. This process makes green plants the foundation on which all other organisms in the ecosystem must rely for energy.

When energy is changed from one form to another, some of the energy is lost in forms other than that desired. When electrical energy is transformed into light energy in a light bulb, some of the energy is lost as heat. No energy conversion is 100 percent efficient, and that includes energy changes in an ecosystem. An animal that gets energy from the plants that it eats is never able to use all the energy contained in its food. Some of the energy is lost as heat and motion. As energy flows through an ecosystem, most of the energy (about 90 percent) is lost to the environment each time it is passed from one organism to another.

You know it is impossible to put light back into a light bulb or to put the heat from a fire back into the log which released it. Once energy has been released, it is extremely difficult to recapture it. Energy is not recycled in an ecosystem. As energy flows through an ecosystem it is used by various organisms and then lost as biologically useless forms, mostly heat. Without a constant supply of energy, an ecosystem will collapse and the biotic community will rapidly become part of the non-living environment.

While energy is not reused by an ecosystem, matter is constantly cycled among organisms and the parts of the physical environment. Such chemicals as carbon, nitrogen, and oxygen move from the atmosphere, water and soil into plants and animals and back again. Energy is necessary for this movement of matter. Life may be defined as a state of chemical activity, and energy is necessary to maintain this living condition and to turn the nutrient cycles necessary for an ecosystem to function.

A system is a real or imaginary part of the universe small enough to be described, studied, or manipulated. Systems, like the universe, consist of matter and energy. If matter can enter and leave a system, it is called an open system. In a closed system, the amount of matter in the system remains constant. If the amount of energy in the system also remains constant, the system is an isolated system. So systems can be open isolated, closed isolated, open not isolated, or closed not isolated.

What kind of system is pond ecosystem? Sunlight enters a pond and may be captured by photosynthetic system components. Heat may also be added to or lost from the pond system, so this system is clearly not isolated. Matter may also be added to or lost from a pond. Water, for example, may enter the system as rainfall and leave through evaporation. Nutrients such as nitrogen or phosphorus may be added to a pond in leaves falling onto the surface and may be lost in fish caught and removed. Therefore, we know it is an open system.

Our planet earth is a closed system for all practical purposes. Only a relatively small amount of matter enters our earth system (meteorites) and a much smaller amount leaves (spacecraft). The great majority of the matter present in the system has been here since earth was formed and will remain here long after all life on earth has perished. In a closed system like earth, matter is cycled and recycled through all parts of the system so that the same matter is used over and over again. On a more personal level, this means that some of the carbon atoms in your left thumbnail may have once been a part of a blood cell in a dinosaur.

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Earth is not isolated. Energy enters our system in many forms, such as x-rays and radio waves from distant stars, but predominately in the form of light from the sun. Energy leaves our system mostly as heat radiating into space. As this energy flows through our system, a tiny fraction of it is used by all the organisms on earth to maintain their state of chemical activity called life.

TITLE:	When Did Man Arrive?
CONCEPT:	A geologic time table will help in studying the past.
PURPOSE:	To familiarize the student with the geologic time table and to make a model.

MATERIALS:
pencil
roll of adding machine tape, 5 m
meter stick
geologic time table

PROCEDURE:

1. Discuss the geologic time table and ask the student if he has any idea how long a million or a billion years is in relation to his life-span.

2. The student is to make a model of the geologic time table using the tape. (Small groups could do this as well as individuals.)

   Hint: The student should mark the top of his strip of paper "NOW" and should plot downward from "NOW" to other points.

   Suggest that a scale of 1 meter = 1 billion years

   1 mm = 1 million years.

3. Make sure that the students clearly understand the technique of scaling.

4. When students have finished, have them place the tapes side-by-side for comparison.

5. If students work accurately, all strips should have representative distances marked off at the end of the activity.

NOTE: For additional practice in scaling, a planet chart could be used.

TITLE: Classification of Rocks and Minerals

CONCEPT: Rocks and minerals are of many different types.

PURPOSE: To allow students to observe the differences and the similarities in rocks and/or minerals. To teach the concept of classification or grouping. (Note: It isn't necessary at this point for the students to know the names of the samples.)

MATERIALS: rock and/or mineral samples (preferably 20 or more per student or group of students)

PROCEDURE:

1. Give each student (or group of students) a box of rocks and/or mineral specimens.
2. Without explaining how, ask them to classify or group the samples several different ways.
3. When they have finished, ask them to explain why they grouped their samples as they did. (You will probably get several different methods -- color, size, crystal size, weight, hardness, roughness, etc.)
4. After discussing the different methods (all are correct), ask them to re-group their samples. This time, limit the number of groups (5 or 6).
5. Continue this activity until a method of grouping is agreeable to most of your students. (Note: At this point, depending upon the level of your students and their interest, you may want to further explain classification. Here you may also wish to go into rock and mineral classification.)

TITLE:	Studying Rocks in a Cemetery
CONCEPT:	There are many different rocks.
PURPOSE:	To study the rocks used in making headstones and monuments.

MATERIALS: pencil
notebook

PROCEDURE:

1. Take a field trip to a local cemetery.
2. Observe and make a list of the different rocks used for the headstones and monuments, based on color, texture, etc.
3. Notice the older monuments. Discuss the reasons some of them have weathered more than others.

TITLE:	Fossil Collecting and Classifying
CONCEPT:	There has been a great variety of marine life in Oklahoma's geological past.
PURPOSE:	To introduce the student to fossil collecting. To give the student a better understanding of life in Oklahoma's past.

BACKGROUND INFORMATION: Tied perhaps as closely to the natural heritage of Oklahoma as a study of rocks and minerals is a study of fossils. Fossils are the remains of prehistoric life, or some other direct evidence that such life existed. So abundant are the fossil remains of Paleozoic and Mesozoic marine life in the sedimentary rocks of Oklahoma, that parts of the state offer some of the best fossil hunting in the country.

There are many good fossil-collecting sites in all sections of the state, particularly in the Arbuckle Mountains, around Lake Texoma, and along the lower Red River. By writing to the Oklahoma Geological Survey you should be able to find out where the best fossil-collecting sites are located in your area.

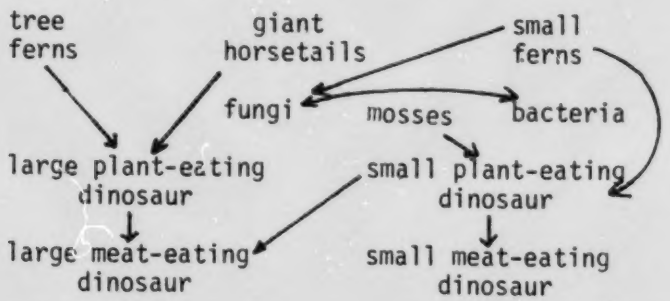
MATERIALS:
collecting bags
geological map

PROCEDURE: The procedure for collecting fossils is essentially the same as for collecting rocks and minerals. A little more difficult perhaps, because fossils are generally smaller. Search along road-cuts (be careful about cars) and in eroded areas. After a sizable quantity of fossils (preferably from more than one site) have been collected, have the students classify them.

TITLE:	Past and Present Food Webs
CONCEPT:	All ecosystems, past and present, function similarly.
PURPOSE:	To compare food webs of past and present ecosystems.

PROCEDURE:

1. Present students with the following components of a prehistoric ecosystem: tree ferns, giant horsetails, small ferns, mosses, small plant-eating dinosaur, large meat-eating dinosaur, fungi, and bacteria. Have the students construct a food web using these plants and animals. Students may want to cut out or draw pictures of these organisms and make a pictorial food web on a poster or bulletin board. The food web may resemble the following:



2. Ask which organisms are still present today, which have changed and which have disappeared completely. Have students name organisms present today which have the same ecological roles as each component of the prehistoric food web. Construct a food web using these modern organisms. Compare corresponding components of the two food webs. Are the food webs more different than similar? What is the energy source for each?

FOLLOW-UP ACTIVITY:

Describe an aquatic food web by replacing the components of either food web with appropriate organisms. Compare this food web to the others. Emphasize the similar roles of the components and how similarly all ecosystems function.

TITLE:	Becoming Aware of an Area
CONCEPT:	Many different things can be found within the boundaries of a small circle.
PURPOSE:	Students will develop powers of observation and classification.

MATERIALS: string

PROCEDURE: Using a string, make a circle about one meter in diameter on the ground.

Have students describe items found within the boundaries of the circle. Non-living materials may be counted. Classify the objects by similarities and differences.

ORGANISM	COLOR	SHAPE	SIZE	NUMBER SEEN	LIVING	NON-LIVING

NOTE: This activity can be used in any location.

FOLLOW-UP ACTIVITY: Suggestions for recreation site. Site may be done as a mural or as a cardboard cutout. Plant and seed catalogues could be used to help select types of vegetation.

TITLE:	Reading Topographic Maps
CONCEPT:	Topographic maps show earth surface features.
PURPOSE:	To teach the students how to read a topographic map.

BACKGROUND INFORMATION:

Since the Ouachita, Arbuckle, and Wichita Mountains were formed, and later, the general continental uplift, the major earthshaping forces at work in Oklahoma have been wind and water erosion. Whatever the force, however, the result is the alteration of the earth's surface, the formation of mountains, valleys, hills, rolling plains, and deep canyons. The condition of the earth's surface is known as its topography (toe-paw'-gra-fee).

A topographic map is one which accurately shows these features. Streams and other bodies of water are shown in blue, forests in green, and man-made structures in black. But, how do you show the hills and valleys?

One of the outstanding features of any topographic map is the closed concentric (kon-sen'-trik) lines (usually brown) called contour lines. These are lines which connect points of equal elevation. All points on a given line are at the same elevation. The lines are all spaced at a set vertical interval. This means that the vertical distance between any two consecutive contour lines is that interval, be it 10 feet, 20 feet, 50 feet, or 100 feet.

The closed lines get shorter as they increase in elevation toward the top of a mountain or hill. If the hill is low and gently sloping, the contour lines will be spaced far apart. If, on the other hand, the structure is a steep-sided mountain, the lines will be close together.

MATERIALS:

7 1/2 minute quadrangles of your area. ($1.25 each from the Oklahoma Geological Survey)

PROCEDURE:

1. Acquire 7 1/2 minute quadrangles of your own area from the Oklahoma Geological Survey.

2. Let the students study the maps on their own for a while.

3. Ask them to locate features they are familiar with, such as a stream, a pond, or a wooded area. If they live in the country, their own home may be shown.

4. Ask the students to locate hills and valleys. Have them determine the contour interval. Ask them to locate a particular hill and give its elevation.

5. What are the highest and lowest points indicated on the map? Where are the steepest and flattest spots?

TITLE:	Profile of a Mountain
CONCEPT:	A contour map indicates the elevation and slope of an area.
PURPOSE:	To allow students to better visualize the surface of an area by looking at a topographic map.

MATERIALS:

contour map (Figure 9.a. and 9.b.)
line chart (Figure 10.a. and 10.b.)
sheet of white paper
pencil

PROCEDURE:

1. Make duplicates of the contour map (Figure 9.a.) and the line chart (Figure 10.b.) for each student.

   Question: What is the contour of the map?

2. Have the student lay the long edge of a clean sheet of paper along the section line CD. Be sure that C is on the left and that the left edges of the two papers are flush.

3. Make a dot or pencil mark on the edge of the measuring paper at each point that a contour line touches it. Label each dot with the elevation number of the contour line it represents.

4. Lay the edge of the measuring paper along the 0-line of your chart. Be sure the left edges are flush. Make a dot on the 0-line corresponding to each 0 dot on your measuring paper.

5. Move the measuring paper to the 50 foot line and make dots for each 50 foot dot on your measuring sheet. Continue this procedure for each line through the 400 foot line.

6. Start with the 0-foot dot on the left and, with a smooth line, connect all the successive dots, ending with the 0-foot dot on the right.

Contour Map

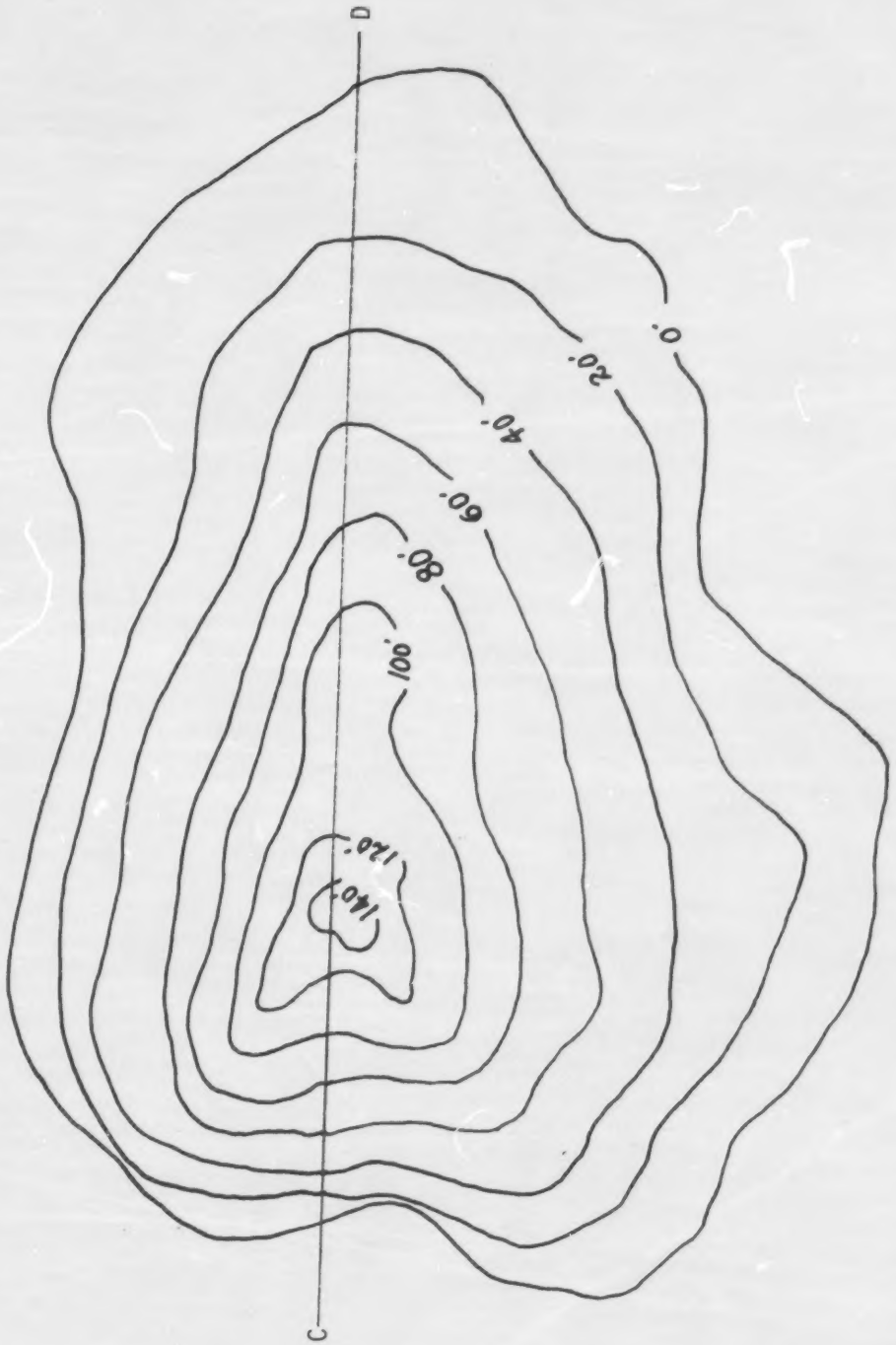


Figure 9.a.

CONTOUR MAP

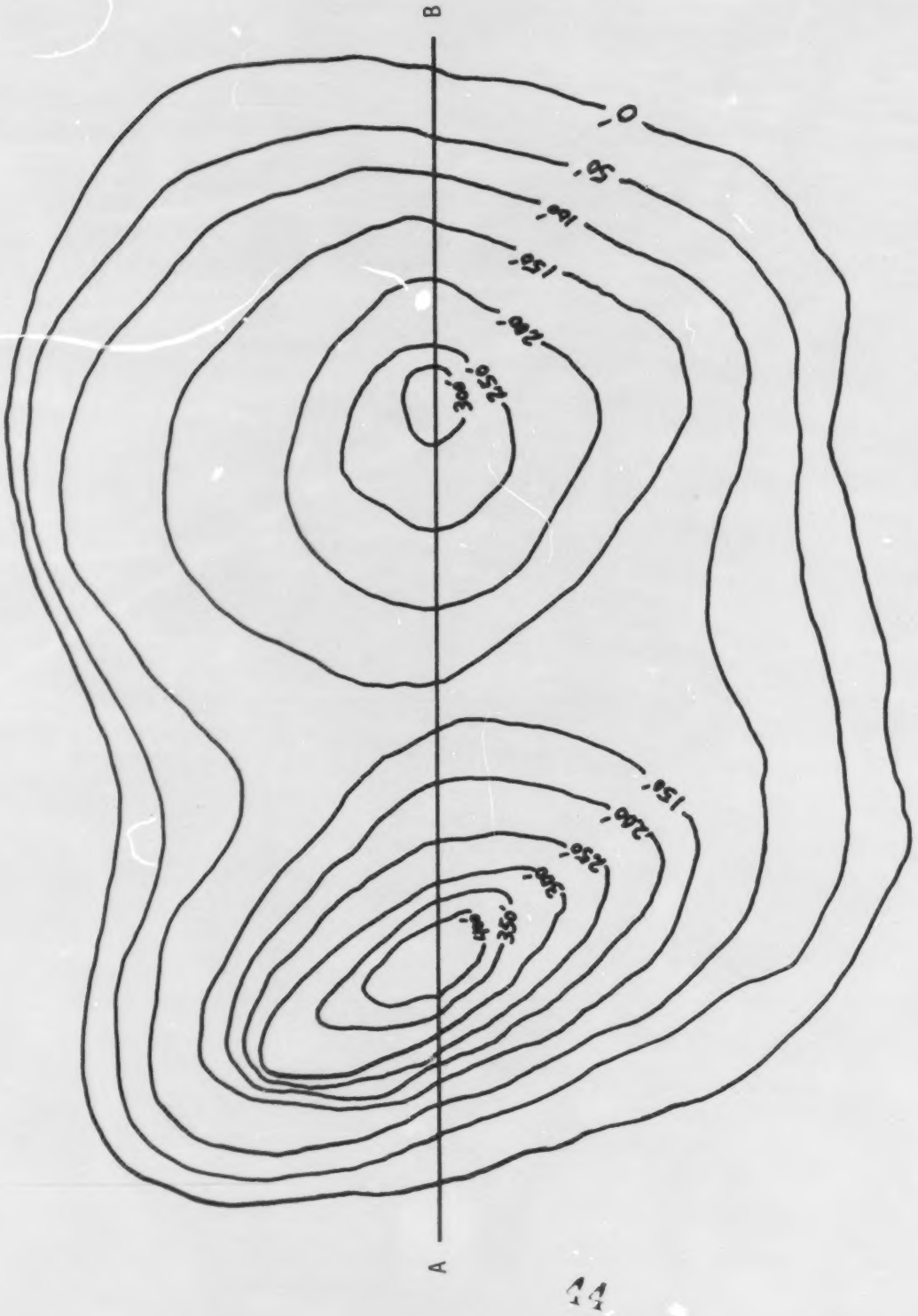


Figure 9.b.

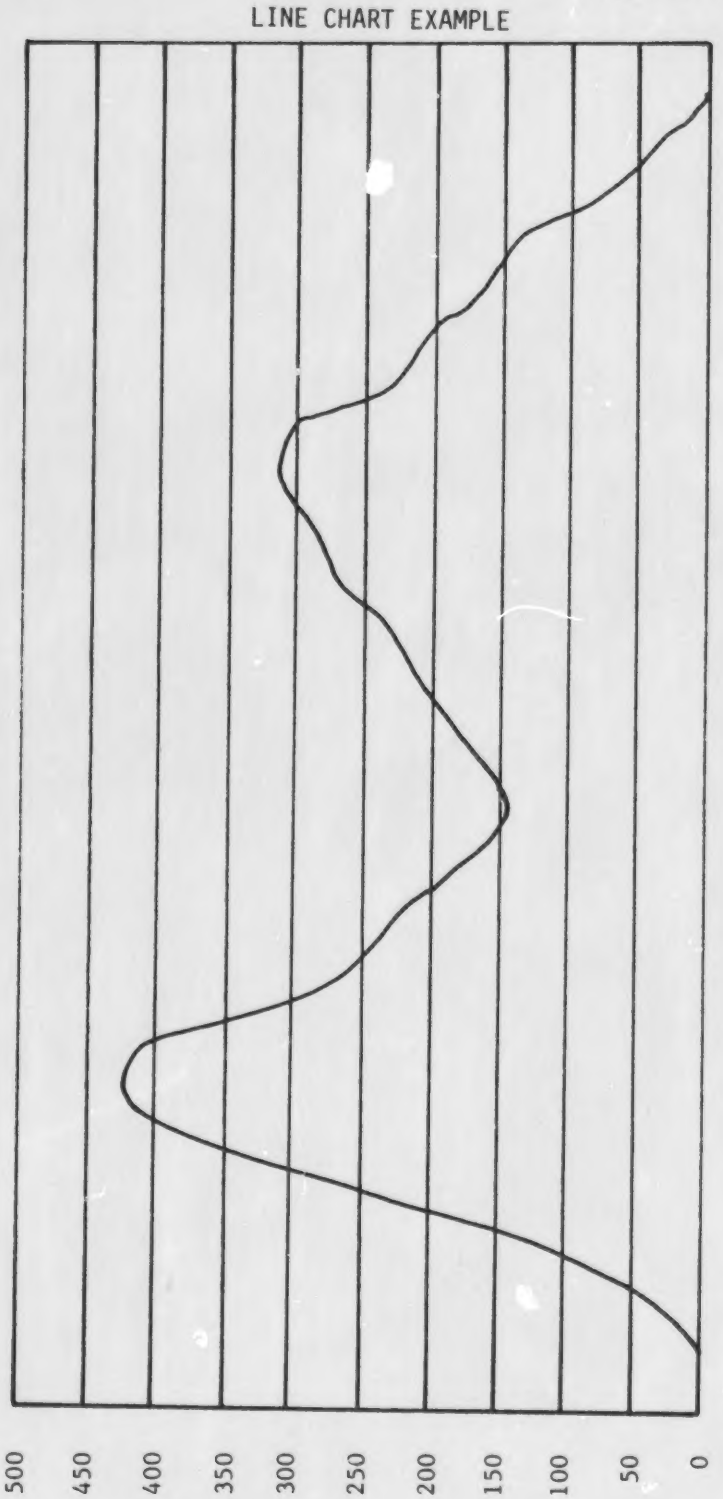


Figure 10.a.

LINE CHART WORKSHEET

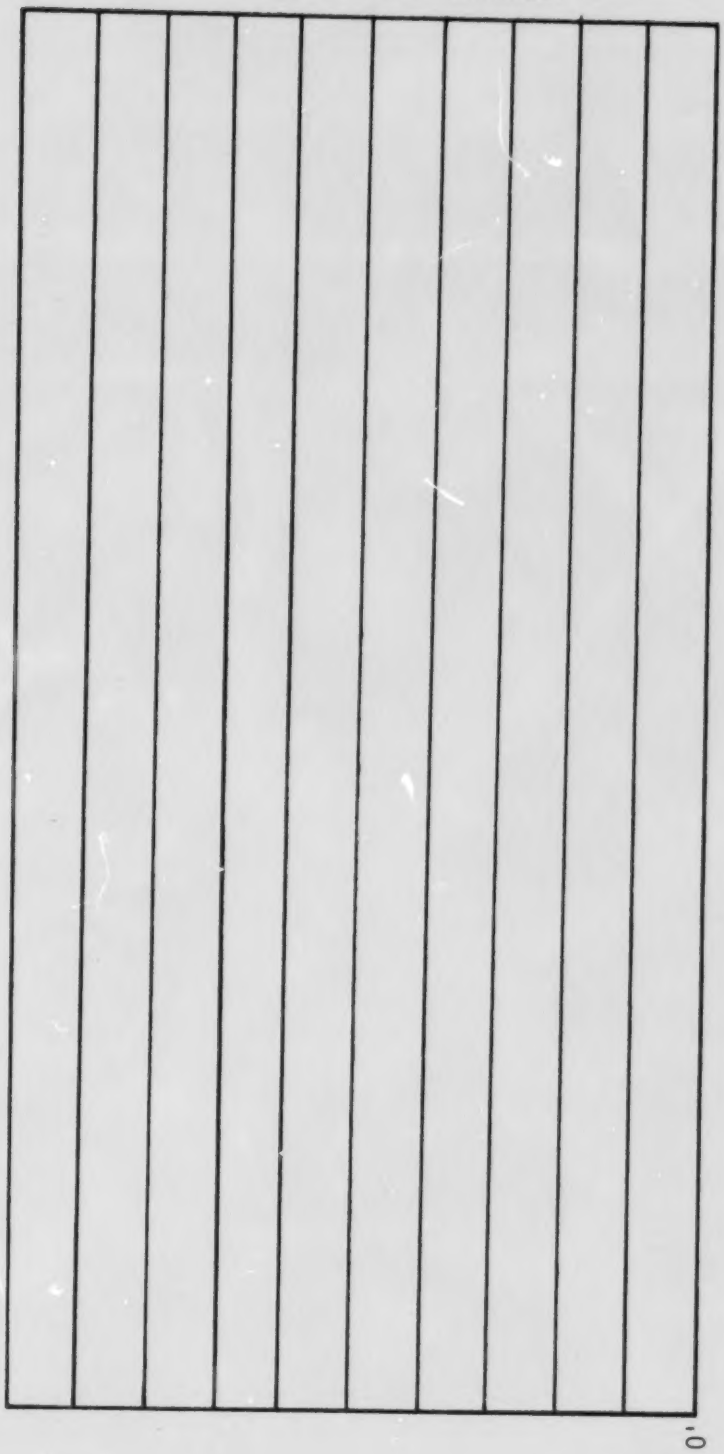


Figure 10.b.

TITLE: Mapping a Study Site

CONCEPT: A map model will aid in the study of the ecosystem.

PURPOSE: To familiarize students with the site to be studied.

MATERIALS: for the class:

large sheet of white poster board or butcher paper
marking pen

for each group:

sheet of poster board or butcher paper
bag of eight different colored tags (tapes, colored pencils, construction paper, contact paper, paper dots)
marking pen

PROCEDURE:

1. Select a site for study and obtain permission to use it.

2. Prepare a large overview map of the site showing the major landmarks (roads, sidewalks, buildings, streams, etc.) in their approximate locations. (This may be done ahead of time or as a student activity.)

3. Show the students the eight different colored tags and have them construct a key to tell them what each colored tag means. Example:

   dark green.....trees
   light green.....bushes
   yellow.....grasses or lawn
   black.....dead trees or logs
   red.....weed beds
   gray.....ant hill
   brown.....gopher holes
   orange.....birds nests

   Special features such as 12 trees close together can be noted by writing a 12 on the appropriate colored tag.

4. Divide the class into groups and assign each group a section of the site. After copying the landmarks of their section from the overview map onto their paper or posterboard, students will be ready to visit the study site and record the features on their small

maps using the color coded tags.

5. Combine all sections onto the large map to produce a color-coded map of the entire study site.

DISCUSSION QUESTIONS:

1. What is the most common color on the map? Which feature does it represent? Which feature is the least common?

2. Which part of the map contains the greatest number of different colors and which part the least? What might explain these differences?

3. Where is man's influence most evident? Where is it least evident?

4. In what ways do you think man may have affected the biological features of the site?

5. What do you think this site looked like 50 years ago?

6. What do you think this site will look like 50 years from now?

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TITLE:	Plant Hunt
CONCEPT:	There is a diversity of plant species in an area.
PURPOSE:	To develop interest and skill in sampling populations. To find and observe some of the plants in an area.

MATERIALS: for the class:

25 paper or plastic cups (cottage cheese or margarine containers)

for each team:

2 egg cartons
hand lens
plant identification books (optional)

PROCEDURE:

1. Have students collect two leaves or pieces of each different plant found in the study site. One piece is placed in the team's egg carton, the other in one of the paper or plastic cups. Put cups out in the middle of the site. Each cup should contain only one kind of plant. If two teams collect samples from the same kind of plant, put them in the same cup.

2. Observe and discuss each team's findings. Students may like making a contest out of the collection. The winner is the team that collects the greatest number of different plants.

3. Ask the students if each piece is really from a different plant. Resolve disputes by using hand lens and comparisons of whole plants. Examine the contents of the cups. Does each cup contain a different plant?

4. Introduce the term species.

5. Distribute plant identification keys. Many students will enjoy finding names for the plants they have found.

FOLLOW-UP ACTIVITIES:

1. Using scientific identification keys, identify each plant to genus and species, if possible.

2. Compare results of plant hunts at different times

of the year and under different moisture conditions (after a rainy or dry period).

3. Try to find species of plants that were not collected.

4. Compare results of plant hunts conducted in different environments.

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TITLE:	Animal Diversity
CONCEPT:	There is a diversity of animal species in an area.
PURPOSE:	To find and observe some of the animals living in a lawn study site. To develop interest and skill in sampling populations.

MATERIALS:

for the class:

poster board for listing animals caught
marking pen

for each group:

sweepnet
2 plastic bags
2 rubber bands
pitfall traps and bait (for follow-up activity)

PROCEDURE:

1. Students may make sweepnets from fine netting or cloth, a wire coat hanger, and a broom stick.
2. Ask students to find as many different animals as they can that are living in the study area.
3. Let students search on all fours for a few minutes (usually unsuccessfully). Demonstrate how to use a sweepnet and how to transfer animals to a plastic bag.
4. Compile a list of animals found. Make up names for animals that are unidentified.
5. Observe any interactions taking place in the plastic bags (animals eating other animals, etc.).
6. When finished, return animals to the grass where they were collected.

DISCUSSION QUESTIONS:

1. How many different animals were collected?
2. Which was the biggest? Which was the smallest?
3. Which animal was most numerous? Which was the least numerous?

4. What colors were the animals? What shapes?

5. Do all the animals have anything in common? What?

6. What interactions between two animals, or an animal and a plant, did you see?

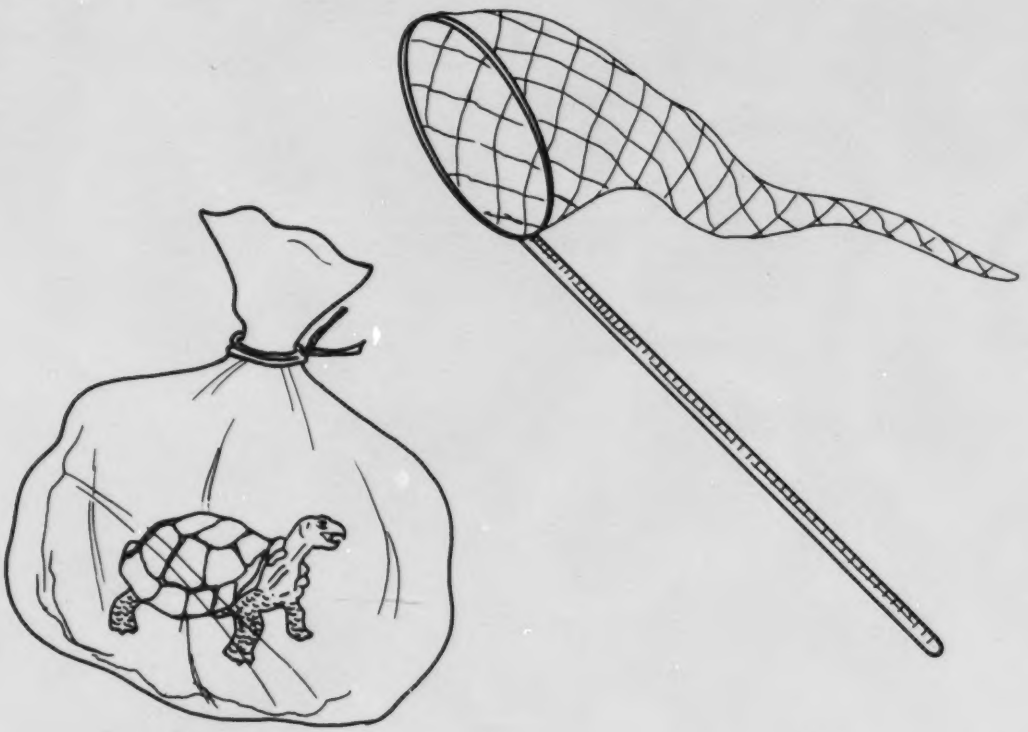
7. Are there animals in the lawn not easily caught with a sweepnet? If so, how could they be captured?

FOLLOW-UP ACTIVITIES:

1. Collect animals in pitfall traps. Compare with animals caught with sweepnets.

2. Compare animals caught at night with those caught during the day.

3. Compare animals caught before and immediately after mowing.



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TITLE:	Terrestrial High-Low Hunt
CONCEPT:	Plant and animal distributions are influenced by physical factors.
PURPOSE:	To investigate the extremes of environmental variables in a study site.

MATERIALS: variable

PROCEDURE:

1. Have student teams find extremes of physical factors within a study site, such as the places which are warmest and coolest, brightest and darkest, steepest and flattest, calmest and windiest, etc. Encourage students to take 6 or more measurements and record values on map of site.
2. Identify (as a group) reasons for these extremes. "What makes this the warmest (etc.) spot?"
3. Look for relationships between factors.
4. Will warmest and coolest spots always be the warmest and coolest? How about the other factors?
5. How might wind direction affect which spots are windiest and calmest? How might time of day affect warmest and coolest, brightest and darkest? How might these factors be affected by the time of year?
6. Introduce the term "environmental variables"...In what ways do these affect man and other organisms?
7. In what ways does man affect the environmental variables.

FOLLOW-UP ACTIVITIES:

1. Repeat at different times of day, different days, different seasons, and compare the results.
2. Compare results from different sites (forest vs. lawn, pavement vs. meadow).

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TITLE:	Invent an Animal
CONCEPT:	Animals are well-adapted to survive in specific environments.
PURPOSE:	To make students think about ways animals are adapted to their environments by having them design animals well-suited to specific conditions.

MATERIALS: for the class:

potatoes, stringbeans, carrots, etc.
white latex paint
popsicle sticks, toothpicks
cotton
glue
plasticene or clay
tempera paint, several colors
paint brushes
masking tape
colored cellophane (for follow-up activity)

PROCEDURE:

1. Paint vegetables white. Select 2 or more different sites far enough apart so students at one site cannot see where "animals" are located in other site.
2. Have students camouflage vegetables (which will serve as the main body part of the animal) for a particular habitat (grassy, leafy, etc.). Both color and shape should be considered.
3. Send each team to a different site. After choosing a particular habitat, each student constructs an "animal" to place in that spot.
4. When all have finished, teams exchange sites and search for camouflaged animals.
5. Bring discovered animals together. Ask inventors of undiscovered animals to point out their well-camouflaged creations.

DISCUSSION QUESTIONS:

1. Why were some found and others not found?
2. In what other habitats would your animal be well camouflaged?

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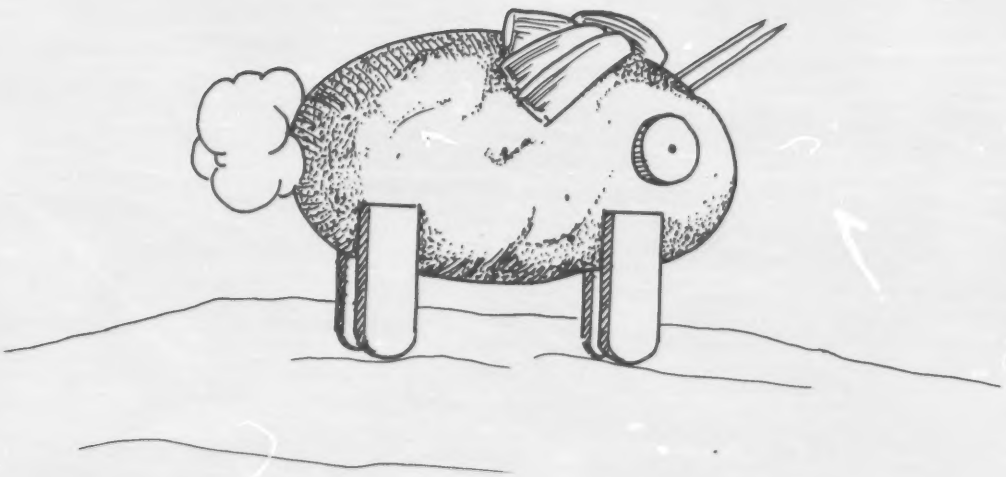
3. Name animals that you know are protected by camouflage. Describe some you have seen.

4. Name animals that you know which are not camouflaged. How do they protect themselves from predators?

FOLLOW-UP ACTIVITIES:

1. Many animals are color blind. Hunt for animals again wearing masks of colored cellophane to simulate limited color vision. Compare results with those before.

2. Design plants well-adapted to specific environments.



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TITLE:	Population Game
CONCEPT:	An animal population varies over time and is limited by the ecosystem carrying capacity.
PURPOSE:	To simulate a deer population and its dynamic relationship to the food supply.

MATERIALS: for the class:

flagging or rope for marking off the home range
kitchen timer, stopwatch, or watch with second hand
data board (poster board or white paper)
marking pen

for each student:

10 home-range poker chips (one color)
4 plastic sandwich bags
6 new-range poker chips (another color)

PROCEDURE:

1. Mark off a circle about 10 m in diameter for the home range. Scatter home-range chips throughout the circle.

2. Choose two areas that are visually obscure from the home range and at least 10 m away. Scatter half the new-range chips throughout each area. These areas will serve as new feeding ranges (available in the fifth round of the game).

3. Reproduce the "number of survivors" chart on the data board.

Year	Number of deer at start	Number of deer that survived
1		
2		
3		
4		
5		

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4. Introduce the Population Game to students. Each plastic bag represents a deer (all bags together represent a population of deer). The chips in the circle represent food plants. The challenge for the students is to collect food for the animals in the herd.

5. Each deer must have at least 5 chips to survive each two-minute round (represents one year). Students may collect more than 5 but not more than 10 chips in a round. Sharing or pooling chips is not permitted.

6. At the end of each round, collect the deer (bags) that did not survive. At the beginning of the next round, hand out an additional bag for each deer that survived, simulating reproduction. Redistribute bags, if necessary, so no student is left without one.

7. Begin play.

   Round 1: The first year. Give each student one bag. Let students collect chips from the home range for two minutes. Count survivors. Collect "dead". Record the data.

   Round 2: Second year. Explain simulation of reproduction. Add one deer for each survivor. Hand out additional bags (all participants should now be collecting food for two deer). Redistribute all the food chips in the home range. Explain that students are determining the carrying capacity of the home range. Take predictions of the number of survivors. Let students collect chips for two minutes. Record survivors, collect casualties.

   Round 3: Third year. Pass out offspring bag to each survivor (some students may now have 4 bags). Redistribute chips in the home range. Play round 3 like round 2.

   Round 4: Fourth year. Hand out offspring to survivors. Announce that because of the large number of deer feeding on the range last year, the food plants have been damaged and food production has been lowered. Remove 1/4 of the chips and redistribute the remaining chips in the home range. Again have students predict carrying capacity. Play round 4 like round 2.

   Round 5: Ask what deer might do if food was scarce (move to a new area). Tell students that in this round, after all available food in the home range is

gone, the herd may disperse and search for new feeding areas. Hand out offspring. Begin round 5. After 2 minutes call everyone together and see how dispersal affected the number of survivors.

DISCUSSION QUESTIONS:

1. In which round was survival easiest? In which was it hardest? Why?

2. What two things determined carrying capacity? (Number of deer feeding and amount of food.)

3. If someone regularly, and over a long period of time, put out a lot of food for deer in a small area, what would happen to the carrying capacity of the area for deer? What would be the effect on the deer population? What would happen if the person moved away?

4. What factors reduce the size of populations?

5. How is human population growth similar to growth of other animal populations? How is it different?

FOLLOW-UP ACTIVITIES:

Students may observe changes in a small population of animals over a short period of time. Guppies are good subjects. Starting with 3 of the little fish (1 male and 2 females) in a properly maintained aquarium, students can follow changes in the size of the population over several months.

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TITLE:	Silent Stalking
CONCEPT:	Predator-prey nutritional relationships are common in nature.
PURPOSE:	To simulate predators stalking prey.

MATERIALS: blindfold for each group of 5 to 10 students

PROCEDURE:

1. Choose a fairly open, level site with a noisy walking surface (dry leaves, gravel, crunchy snow, etc.). Mark off a stalking circle at least 10 m in diameter. If more than one circle is needed, mark off additional circles at least 40 m apart.

2. One member of the group is selected to be the prey, the rest are predators. The prey is placed in the center of the circle blindfolded. Predators encircle the prey 5-8 m away. Masked prey spins about 4 times while predators walk around the circle. Prey yells "stop" and everybody halts.

3. Predators begin to stalk the prey, stopping after each step. Prey tries to pinpoint the predators by listening (the pause after each step takes the place of an escape response).

4. The prey tries to point at predators. When prey points, a referee yells "freeze" and judges the point by moving behind the prey and sighting along the prey's pointing arm and announces "hit" or "miss ". A hit occurs when the prey's finger points directly at or above a predator (direction is important, not height). Hit predators leave the circle. Successful predators (those which are able to touch the prey without detection) also leave the circle. Non-participants must watch the rest of the game quietly.

5. The game ends when all predators have tagged the prey, when all predators have been eliminated, or when the prey has used up all available detection attempts. (The prey is given a number of attempts equal to twice the number of predators.)

VARIATIONS:

1. The game may be played at night with a narrow beam flashlight instead of pointing. The flashlight beam may be narrowed by attaching a paper cone to the end of the flashlight.

2. Compare the results when the prey has a simulated hearing loss (place cotton in the ears of the prey).

3. Compare the results when the game is played on all fours.

4. Compare the results of the game played on various walking surfaces.

DISCUSSION QUESTIONS:

1. Ask students how they would change their bodies in order to be more effective as predators or prey.

2. Ask the most successful predators to demonstrate their silent stalking skills.

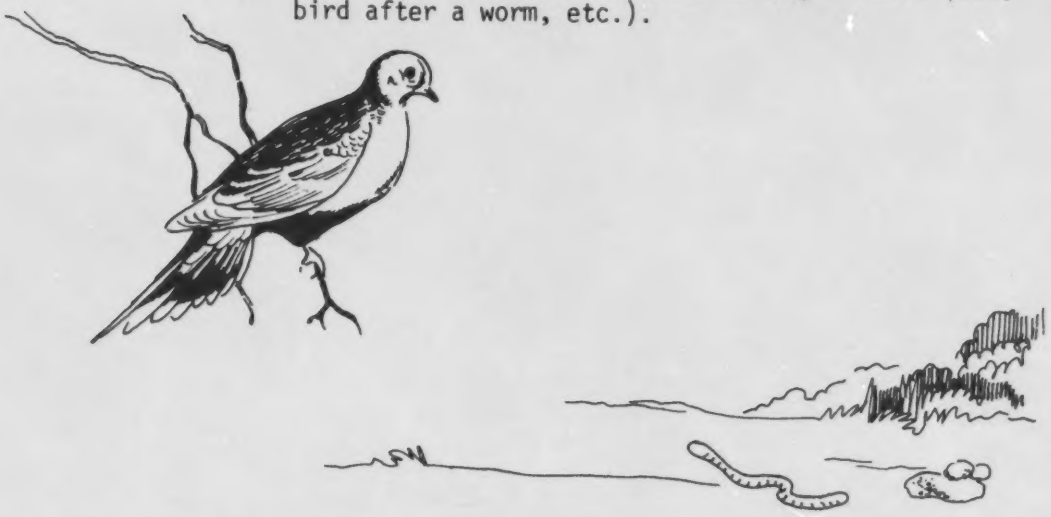
3. Have students name predators found in Oklahoma. Students may want to make oral or written reports about these animals, their prey, their habitats, etc.

4. Have students identify predators that lived in Oklahoma in the past but are not here now. Discuss what happened to them and why.

FOLLOW-UP ACTIVITIES:

1. Challenge students to get close to a bird, cat, fish, butterfly, squirrel, or lizard. Have a close-up wildlife photo contest (no telephoto lenses allowed).

2. Encourage students to watch stalking animals (cat, bird after a worm, etc.).



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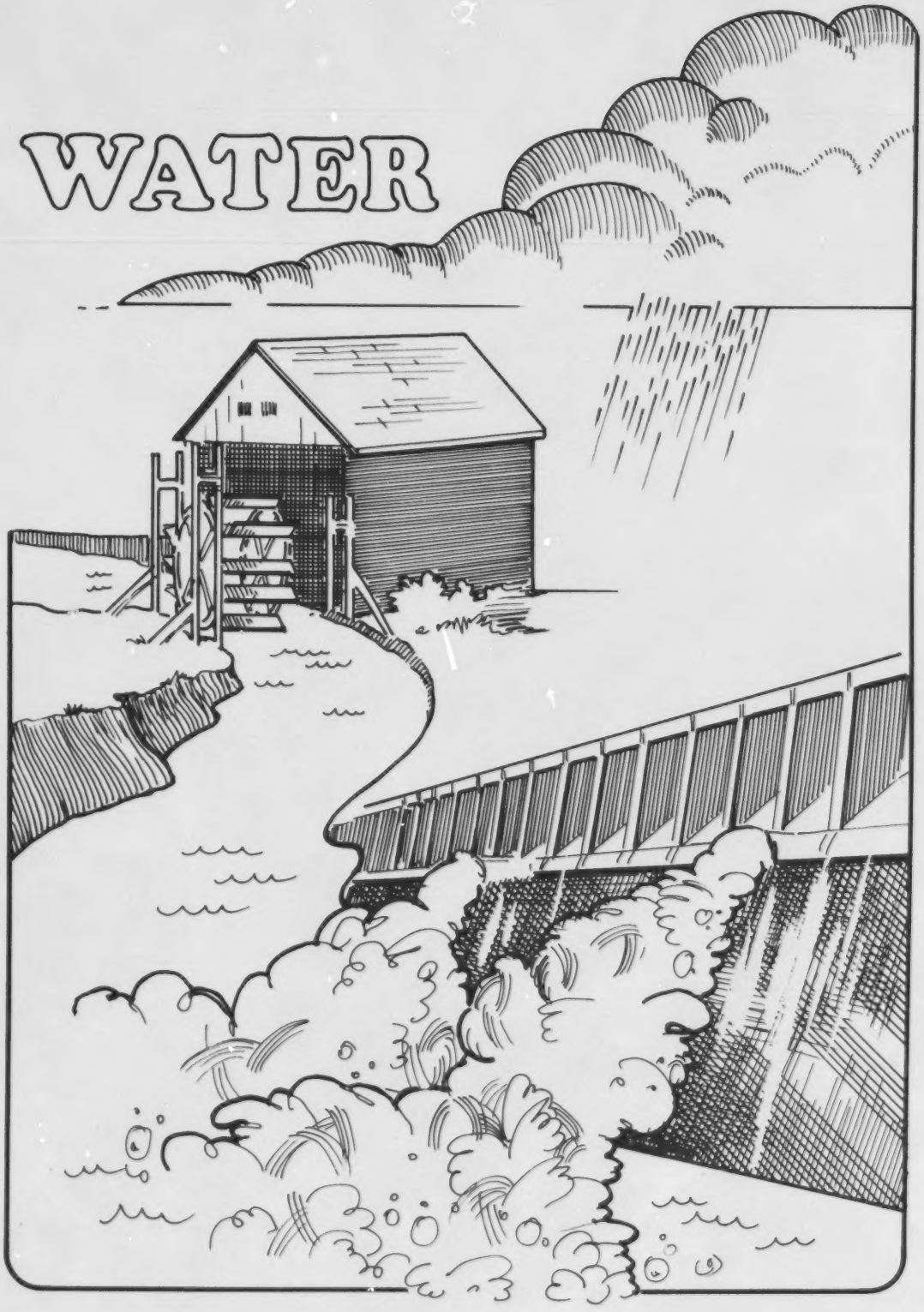
WATER

CHAPTER 2

WATER

Millions of years before man appeared on earth, water affected the formation of the land that is now Oklahoma. Several times in the geologic past, the state was completely covered by shallow seas. Over long periods of time the water carved many of the land and water courses that are still visible today.

Surface water (rivers, streams, lakes, etc.) as well as ground water is directly related to climate, land forms, elevations, geologic formations, and vegetation. Oklahoma has within its boundaries a variety of climatic conditions and, therefore, uneven distribution of available water.

Let's take time to study the general climatic conditions of our state

TOPOGRAPHIC FEATURES

Oklahoma is located in southern Great Plains. Of the 50 states, it ranks 18th in size with an area of approximately 70,000 square miles, only 935 of which are covered by lakes and ponds. Its northern boundary is about 465 miles in length and its southern boundary 315 miles in length. The greatest distance north to south is 222 miles.

The terrain is mostly rolling plains, sloping downward from west to east. The plains are broken by scattered hilly areas where most points will be 600 feet or less above the adjacent countryside, and by a moun-

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tainous area in the southeast where some peaks rise more than 2,000 feet above their base. The hilly areas consist of the Wichita Mountains, with some isolated peaks in the southwest; the Arbuckle Mountains in the south-central; and an extension of the Ozarks in the northeast. The Ouachita Mountains occupy much of the southeast. Elevations in the state range from 4,976 feet above sea level on Black Mesa in the northwestern corner of the Panhandle, to about 305 feet in the bed of the Red River where it leaves Oklahoma at the southeastern corner of the state.

Oklahoma lies entirely within the drainage basin of the Mississippi River. The two main rivers in the state are the Arkansas which drains the northern two-thirds of Oklahoma and the Red River which drains the southern third and forms the state's southern boundary. Principal tributaries of the Arkansas are the Verdigris, Grand (Neosho), Illinois, Cimarron, North Canadian, and Canadian.

CLIMATE FEATURES

The climate of Oklahoma is continental in type, as in all of the central Great Plains. Warm, moist air moving northward from the Gulf of Mexico exerts much influence at times, particularly over the southern and more eastern sections of the state where, as a result, humidities and cloudiness are generally greater and precipitation considerably heavier than in the western and northern sections. Summers are long and occasionally very hot. Winters are shorter and less rigorous than those of the more northern Plain States. Periods of extreme cold are infrequent.

Low humidities and good southerly breezes usually accompany the high temperatures and somewhat lessen their discomforting effect. Occasionally strong, hot winds accompany the high daytime temperatures; this

combination produces rapid evaporation and often injures crops. When these conditions persist for long periods of time, droughts develop and occasionally become severe. Nights are generally comfortable because the clear skies and dry air allows for rapid cooling after sunset.

TEMPERATURE

The mean annual temperature over the state ranges from 64°F along the southern border to about 60°F along the northern border. It then decreases westward across the Panhandle to about 57°F in Cimarron County. Temperatures of 90°F or higher occur, on an average, about 85 days per year in the western Panhandle and in the northeast corner of the state. In the southwest, the average is about 120 days, and in the southeast from 95 to 100 days. Temperatures of 100°F or higher are common over the state from May well into September. In the southwest part of the state the average number of 100°F days is 20 to 25 per year. Other sections of the state will average somewhat less, but very seldom will any location in the state not reach a 100°F temperature sometime during the summer.

The highest temperature ever recorded in the state was 120°F. This reading was observed at Alva on July 18, at Altus on July 19 and August 12, and at Poteau on August 10 -- all during the extremely hot summer of 1936. Tishomingo also observed a 120°F temperature on July 26, 1943.

Temperatures of 32°F or less occur on an average of 55 to 65 days per year along the southern tier of counties and from 90 to 100 days per year along the Kansas border in the north-central and northeastern sections of the state. In the Panhandle, days with 32°F or less occur, on an average, 125 to 140 days per year. The lowest temperature of record is -27°F and was observed at Watts on January 18, 1930, and at Vinita on

February 13, 1905.

The average length of the growing season, or freeze-free period, ranges from 168 days at Kenton, in the northwestern corner of the Panhandle, to about 225 days along the Red River in the south-central and southeastern sections of Oklahoma. Along the northern border of the state, the average date of the last spring freeze varies from April 5 in the northeast to April 27 in the western end of the Panhandle. Along the southern border, the average date varies from March 27 to April 5. The average date of the first fall freeze varies from October 12 to October 27 in the north and from November 5 to November 10 along the southern border, the latest dates occurring in the south-central area. Freezing temperatures have occurred as late as April 20 along the southern border and as late as May 15 in the extreme northwest and in the Panhandle. Fall freezes have occurred as early as September 20 in the Panhandle and as early as October 9 along the southern border.

Frozen soil is not a major problem, nor much of a deterrent to seasonal activities. Its occurrence is rather infrequent, of very limited extent, and of brief duration. The average maximum depth that frost penetrates the soil ranges from less than three inches in the southeastern corner of the state to more than 10 inches in the northwestern portion. Extreme frost penetration ranges from 10 inches in the southeast corner to about 30 inches in the northwest corner of the Panhandle. Factors having an important bearing on frost penetration are severity and duration of temperature below freezing; condition, character, and moisture content of the soil; and amount and character of protective cover of the soil including snow cover.

PRECIPITATION

The geographical distribution of rainfall decreases sharply from east to west. Average annual precipitation ranges from about 56 inches in southern LeFlore County, in the southeastern corner of the state, to 15 inches in the extreme western Panhandle. The greatest annual precipitation recorded at an official reporting station was 84.47 inches at Kiamichi Tower in southern LeFlore County in 1957. The least annual amount was 6.53 inches at Regnier in northwestern Cimarron County in 1956.

Frequency of rainfall, as determined from the average number of days with 0.01 inch or more, varies from 95 to 100 days a year in the extreme east to from 70 to 80 days a year over the western third of the state.

Precipitation is usually adequate for successful production of the state's principal crops. Spring and early summer rains are more general and abundant. Late summer and early fall rainfall is more localized and less abundant as a rule. Fall precipitation, except in some western districts where occurrence at this season is uncertain, is usually adequate for putting soils in good workable condition and for giving fall-sown grains a good start. Average summer rainfall of less than 2 inches per month is unfavorable to crops maturing during that season of the year. Poor yields usually result even on good soils unless monthly rainfall exceeds 2 inches.

Excessively heavy rains occur at times. Amounts of 10 inches or more within a 24-hour period, have been recorded. The greatest official rainfall, within a 24-hour period, was 15.50 inches at Sapulpa on September 3-4, 1940. Larger unofficial amounts have been recorded and in a

shorter period of time; for instance, 24 inches in a 10-hour period in the Hallett-Meramec area in southern Pawnee County, also on September 3-4, 1940, and 23 inches within a 12-hour period on April 3-4, 1934, near Cheyenne in Roger Mills County.

SNOWFALL

The geographical distribution of annual snowfall is usually almost the reverse of the annual precipitation pattern and ranges, on an average, from approximately 2 inches in the southeastern corner of the state to approximately 20 inches in the western sections of the Panhandle. Snow rarely remains on the ground more than a few days. At times, strong winds with heavy snowfalls cause severe drifting and occasionally produce blizzard conditions which restrict highway traffic and endangers livestock. The greatest seasonal snowfall ever recorded in Oklahoma was 87.3 inches at Beaver, in Beaver County, during the season of 1911-12. The greatest daily snowfall was 23 inches at Buffalo on February 21, 1971.

FLOODS

Floods may occur during any season. They occur with greater frequency, however, from May to July and in September and October, representing periods when storms are of greater magnitude and rains of greatest intensities. In general, floods in other seasons are the result of more abnormal and persistent buildup of soil moisture plus a concurrent increase in stream-flow due to prolonged rains. The number of lakes built in Oklahoma within the past 20 years has done much to reduce flood damage.

DROUGHT

Oklahoma, along with other states in the southern Great Plains, has

at times been subject to droughts of varying degree and duration, although drought years have been far less frequent than dry summers and falls. Most notable of the drought periods in Oklahoma were the dry years which occurred in the late 1890's, the drought of 1910 to 1919, the very severe drought of the 1930's, and the drought which persisted from July 1951 to March 1957. While little can be done to correct deficient rainfall, which is the major contributing cause of droughts, much has been done since the late 1930's in adapting land use and cultivation practices to climatic deficiencies. The tremendous increase in the past 20 years in irrigation farming has also played a major role in reducing drought conditions in Oklahoma. Since 1947, farmland under irrigation has increased from 50,000 acres to approximately 600,000 acres -- a 12-fold increase. Most of the irrigated land is in the western third of the state.

OTHER CLIMATIC FEATURES

Average annual lake evaporation varies from about 48 inches in the eastern section of the state to as high as 65 inches in the southwestern corner. In the western Panhandle, approximately 58 inches of water is evaporated each year. The importance of these evaporative losses from reservoirs and other surface water supplies has prompted a good deal of research to find ways of retarding the evaporation process.

Prevailing winds are southerly although northerly winds predominate during the winter months. Average yearly wind speeds vary from 9 mph in the east to approximately 14 mph in the west. March and April are the windiest months, and July and August the calmest.

Thunderstorms occur, on an average of, 50 to 60 days per year in the

eastern half of the state, and from 40 to 50 days per year in the western half. Some of the more severe thunderstorms are accompanied by tornadoes and damaging hail, and approximately 75 percent of these occur during the spring season. Since 1875, over 1600 tornadoes have struck the state. One of the most destructive moved out of the Texas Panhandle on the evening of April 9, 1947, striking Ellis, Woodward, and Woods Counties before moving into Kansas. One hundred and one people lost their lives in Oklahoma, 95 percent of these at Woodward, Woodward County. Property damage in the state was a little over $8 million. Since 1924, estimated damage from hailstorms has averaged a little over $3 million per year. The most destructive hailstorm known to have hit the state struck Oklahoma City during the night of May 23-24, 1968, causing over $20 million in property damage.

Skies are preponderantly clear in western and central sections and about equally clear and cloudy in eastern sections. Sunshine records show an annual average of 68 percent of the possible amount at Oklahoma City and 65 percent at Tulsa. Summer is the period of greatest possible sunshine and winter the least.

Relative humidity averages about 10 percent higher in the eastern portion of the state because of lower elevations and more frequent inflow of Gulf moisture. Summer afternoon and early evening relative humidities are considerably lower than those of winter.

CLIMATE AND ECONOMY

Agriculture, mining, manufacturing, trade, and government are all important sectors of Oklahoma's economy. Leading agricultural crops and their main areas of production are: wheat, western half of the state;

cotton, southern two-thirds; corn, eastern half; peanuts, south; broomcorn, central and west; and milo, western half, especially in the Panhandle where a tremendous agricultural economy, based on irrigation from ground water, has been developed. The livestock industry is of great importance to all sections of the state. Minerals produced in the state include petroleum, natural gas, coal, lead, and zinc. Leading manufactured products include food products, transportation equipment, primary and fabricated metal products, machinery, and petroleum and coal products. Lumbering is important in the southeast.

The climate of Oklahoma is favorable for a wide variety of recreational activities. The wooded and more watered and mountainous eastern sections of the state are particularly attractive to vacationers who enjoy boating, water-skiing, camping, hiking, and fishing.

How do these factors affect each of us in our daily lives?

Man can exist on a gallon or so of water a day for cooking, drinking, and washing, although he seldom does, nor has he had to except in rare instances. In Medieval times he probably used no more than three to five gallons of water per day. In the nineteenth century, particularly in the Western nations, man used an average of 95 gallons of water per day. At the present time in the United States, we use about 1,500 gallons per day/per person for our personal needs and comforts such as recreation, cooling, food production and industry.

Obtaining the desired quality and quantity of water necessary to meet the needs of our people is no easy task. Since statehood in 1907, development and improvement of our water resources has been constant. Our water supply comes to us in the form of precipitation and currently

man can do little to change the earth's water cycle. The amount of water on earth is finite (fi'-nit) and limited, therefore, conservation of water is an absolute necessity if we are to maintain a high quality of life in this generation as well as those to come. We must plan wisely for the use and re-use of our water resources for the future.

The water we use (and waste) so freely is part of a never-ending recycling process carried on by nature. It is constantly being exchanged between the earth and the atmosphere. Water evaporates upward from the ground, from the vegetation, and from the many lakes, rivers, and streams. Water is given off by plants through transpiration (tran(t)s-pa-ra'-shan), animals through respiration (res-pa-ra'-shan), and machines through combustion, and all in their own way contribute to the total water vapor. Most of the vapor in the atmosphere is evaporated from the salt water oceans. The water vapor condenses to a liquid and is returned to the ground in the form of rain, hail, sleet, mist, and snow. The rain then runs off the land to the rivers and lakes, and then to the ocean as surface water, or seeps slowly into the soil and rocks to become ground water. Surface water also evaporates from the land and water surfaces to begin the cycle all over again.

As you can see, there is no "new" water. The next glass of water you drink may contain some of the same water molecules that were in the Red Sea when Moses, according to the Bible, parted the waters and led his people to freedom. Or perhaps some of the water you bathe in this evening was once used by a dinosaur in prehistoric times. This mathematical oddity is the result of the tremendous number and extremely small size of water molecules and points to the general acceptance of water as being a

renewable resource.

The average annual amount of surface water that flows into Oklahoma from surrounding states in the two primary river systems (the Arkansas and the Red River) is about 13 million acre-feet. (An acre-foot of water is the amount of water it would take to cover an acre of ground to a depth of one foot). On the average, another 120 million acre-feet of water falls on the state each year. About 22 million acre-feet of the rainfall becomes runoff in the river system. The part of the precipitation that does not become runoff is lost from the river system by evaporation, transpiration, storage in lakes and reservoirs, or seepage into the ground to become ground water.

Although most water used in Oklahoma comes from surface sources such as lakes or reservoirs, ground water supplies us with about 20 percent of our fresh water. At least 95 percent of rural residents use ground water (from wells) for domestic use. Upper level aquifers (ak-'wa-fars) are recharged naturally and may be considered renewable; however, deep aquifers often take tens or hundreds of thousands of years to replenish. In the Panhandle of Oklahoma, water tables have been dropping sharply as water is pumped from the ground for agricultural and urban use.

The amount of water that becomes ground water is only a very small part of the total precipitation, and, although this percentage may vary greatly from year to year and from place to place, it generally is less than 5 percent.

There is evidence that in many areas the amount of water used from the ground water reservoir exceeds the amount replenished by seepage. For example, that area of the state from the Panhandle to the central

area of the state draws most of its underground water from one aquifer, the Ogallala formation. The water is presently being pumped out at an estimated rate of 10 million acre-feet annually, however, the annual recharge rate is estimated to be only about .27 million acre-feet.

In recent years, laws have been passed to solve pollution problems in rivers, lakes, and oceans. Relatively little has been done to protect ground water sources. Seepage from garbage dumps, mining, septic tanks, feedlots, radioactive waste, injection wells, agricultural pesticides,and herbicides is finding its way into our underground aquifers and may contaminate our ground water supply to the extent that it is no longer fit for use by man. Cleaning up a stream can be accomplished in a short time -- a lake much longer, but underground water sources take even longer to be renewed by natural processes.

Many people define a water pollutant as anything put into the water which was not there in its natural state. Any substance can be a pollutant if too much of it is present and how much is too much depends upon the water use which is involved.

There are eight general categories of water pollutants:

ORGANIC

These oxygen demanding wastes come from human, animal, and plant life; from food processing and certain other manufacturing processes. Nature breaks down such wastes in a manner very much like the digestion of food in the human stomach. The metabolism of food in the human body requires oxygen, supplied through the lungs and blood stream.

DISEASE CAUSING WASTES

These also come from humans, animals, and from some manufacturing

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processes -- especially meat packing and tanning operations. Although modern disinfectants minimize the danger from such pollutants, they must be carefully controlled and constantly watched. Some disease-causing microbes develop resistance to disinfection and new formulas must be created.

Sewers collect the waste water from homes, buildings, and many industries and deliver it to treatment plants which are supposed to make it fit for discharge into rivers or streams or for reuse. Some of these systems are efficient, others are not. Many are inadequate for today's pollution control requirements. This is not due to a lack of knowledge. Technically, most water pollution can be controlled. The deterrent has been planning, financing, building, and operating facilities to meet rapidly increasing needs.

There are two kinds of sewer systems -- combined and separate.

Combined sewers carry water polluted by human wastes and storm water that drains off buildings, streets, and land.

Separated sewers divide up those two sources. One -- called a sanitary sewer -- carries only the water polluted by human waste. The other called a storm sewer -- takes care of rainfall, melting snow, and street washing.

Except in rural areas where there is no sewerage system, or in others where septic tanks are used, every home and building has a pipe which carries waste water and sewage to a larger sewer beneath a nearby street. These are connected to trunk or main line sewers.

In separate sewer systems, storm water carries sediment, oil, grease, and other pollutants from lawns, driveways, streets, roofs, and

construction sites. As a result, urban storm water is becoming more recognized as a cause of water pollution.

PLANT NUTRIENTS

Nitrogen and phosphorus compounds are plant nutrients essential to plant growth. Small amounts are present in natural waters. Large amounts are contributed by sewage, certain industrial wastes, and land drainage.

Pollution problems develop when excessive amounts get into water, especially lakes or ponds where the water has little flow, since algae and water plant growth may be overstimulated.

TOXIC SUBSTANCES

These substances come in the form of synthetic organic compounds such as solvents, cleaning agents, and bug killers, and inorganic substances such as mineral salts and acids. Some of these cause taste or odor problems. Others are toxic even in low concentrations.

PERSISTENT SUBSTANCES

These substances are not normally biodegradable. Certain organic compounds are in this category; and inorganic materials are not subject to biological breakdown. They get into water from natural sources due to rainfall, runoff, seepage, and, to a considerable degree, from agricultural practices and various industrial operations.

SEDIMENTS

Particles of soil, sand, and mineral sediments are conveyed in water as silt from land runoff and highway and building construction.

These can be a major problem because of their magnitude. They settle to the bottom of rivers and harbors, requiring expensive dredging;

get into reservoirs, reducing their capacities and useful life; erode power turbines and equipment, and reduce fish and shellfish populations by covering their sources of food. If organic, they may decompose and exert additional oxygen demand.

RADIOACTIVE SUBSTANCES

These pollutants result from mining and processing radioactive ores and the use of refined radioactive materials for industrial, medical, and research purposes. They also result from fallout following nuclear weapons testing in the atmosphere.

HEAT

Heated water speeds up the rate of biological degradation. Power and manufacturing plants use water for cooling purposes. In some instances, the cooling water must be cooled before it is released.

Summer temperatures also contribute to thermal pollution problems. Warm water holds less oxygen and absorbs less from the air, disturbing the oxygen and biological balance.

PROBLEM

Population and industrial expansion during the last 50 years has vastly increased the volume of potential water pollutants so that, in some instances, nature's self-cleansing capabilities are overwhelmed. Where this is so, the problem is man-made and demands man-made solutions. Water pollution can be controlled through application of technology.

Water is essential to all forms of life. It is the solvent for substances contained in living cells and is the medium for metabolic processes in general. If an organism is to maintain its normal water content, all the water it loses must be exactly offset by the amount of

water it takes up.

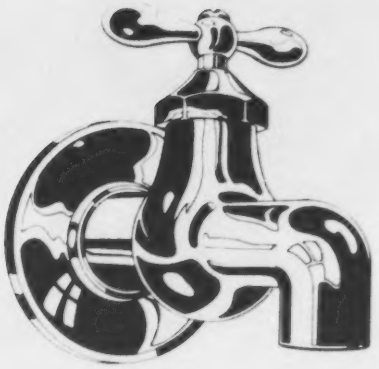
One of the more uncomfortable human conditions is thirst. A lack of water reduces the secretions of the salivary glands, the mouth and throat dries and we seek water. However, the major stimulus to drink is an imbalance of water and salts in the blood. The higher concentration of salts signals the hypothalmus of the brain and we seek water. Eating salty foods also increases the blood's salt content and creates thirst. Humans require an intake of about one and one-half quarts of water per day. We can survive about 80 days without food, but only a few days without water. The human body requires relatively great amounts of water to flush out waste materials and to regulate its temperature.

Water is essential for most living things. Although water is a renewable resource, water management and conservation must begin on the land where the raindrops fall. We must keep in mind that of all of the water in existence today, 97 percent is in the oceans and is, therefore, too salty for human consumption. This means 3 percent of the total water is considered to be potable (pot'-a-bal) (suitable for drinking) and 3/4 of that is in the form of icebergs.

This country was built on a seemingly limitless supply of fresh water. First in the countless lakes, ponds, streams, and rivers; then in ground water tapped by wells and used freely for all human needs. But, like everything else, there are limits to the fresh water supply. Population growth is a big part of the problem. Our demands are increasing and we are using our ground water reservoirs at a much faster rate than they can be replenished.

Somehow, we can get along without most things, substituting for what

is scarce, improvising, and applying our ingenuity. But one thing for which there is no substitute is water! Think about it.



TITLE:	The Sunshine of Our Lives
CONCEPT:	An ecosystem is maintained by energy flowing through it.
PURPOSE:	To observe the changes that result in a pond water micro-ecosystem when the input of energy (sunlight) is halted.

MATERIALS: for each team:

2 large glass containers (about 1 liter) with covers (not airtight)
pond water containing a variety of organisms including algae
aluminum foil
masking or cellophane tape
microscope or hand lens (optional)

PROCEDURE:

1. Students may collect pond water for themselves, or a few students may provide water for the entire class.
2. Have students examine the water and describe and record its characteristics (clarity, odor, variety of organisms, color, sedimentation, number of organisms, etc.).
3. Students should place equal amounts of water in each container. Completely cover one jar with aluminum foil to prevent light from entering the jar. Place the other jar where it will receive plenty of light but not too much direct sunlight. Be sure jars will not be disturbed for several days (about 1 week).
4. Have students examine the water samples again after several days and record their observations. Compare both samples to original observations.

DISCUSSIONS:

1. How were the two samples different from each other?
2. Which seemed healthier? Which would you rather swim in?
3. Which was most similar to the pond water at the beginning of the experiment?

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TITLE:	Where Does it Come From?
CONCEPT:	Water changes as it flows from its original source to your faucets and returns again to the earth.
PURPOSE:	To help students to understand their local water supply. To gain appreciation of our water systems.

BACKGROUND INFORMATION:

Pure water does not actually exist in nature. Water is such a powerful solvent that every drop of rain carries dissolved or suspended material such as dust, oxygen, nitrogen, and carbon dioxide. These substances give water its taste. Too great an amount of chemicals makes water unusable.

The availability of adequate, clean water is a necessity of ever increasing importance. (Your students ought to be convinced of this by now!) Fortunately, government, business, and individuals have begun to awaken to the full impact of this requirement. Large areas of ground water, naturally clean and of excellent bacterial quality, are being contaminated where shortsighted methods of sewage disposal are being employed.

Since two of the dangers to avoid are over-pumping and pollution to ground water, it is encouraging to know that sound regulations have been established in many places controlling pumpage and waste disposal. Clean water will cost more each day that we wait to clean up our pollution.

What is your town's situation? How does your city handle these problems?

MATERIALS:

paper
pencil
local resource people
local map

PROCEDURE:

1. Call your Chamber of Commerce, County Health Department or utility board to find out about your local water supply.

2. Take a field trip to visit the water plant or invite a resource person to your classroom.

3. Find answers for the following questions:

a. Where is the water source?

b. How much does it hold?

c. Are there precautions for flood control?

d. How much water is currently there?

e. How much water does the city use daily, weekly, monthly, yearly?

f. What is the average annual rainfall for the area?

g. How dependent on this rainfall is the area? How long could people survive without it?

h. How and where is the water cleaned?

i. What is involved in the cost to maintain the water system?

j. How long is the water projected to last?

4. As a follow-up activity, have your students find questions for the following answers:

a. Nobody knows for sure.

b. It might happen, and it might not.

c. They might be harmful, and they might not.

d. Water pollution.

e. Costs too much.

f. Conservation and preservation.

g. Survival.

h. Human resources.

i. It's got to go somewhere.

TITLE:	Chain Gang Water Hauling Activity
CONCEPT:	Students should become aware of the amount of water required by each person every day.
PURPOSE:	To appreciate the water systems we have today.

MATERIALS: one gallon container per student (plastic milk carton can be used, simply cut off the top of the container leaving about a 12 cm diameter opening)
three 50 gallon drums or equivalent storage vats
pond, body of water, or water faucet, preferably out-of-doors

PROCEDURE: At body of water: Fill up the 50 gallon drums, as fast as possible without getting wet! Depending on the individual teaching setting, the teacher may want to discuss methodology before going outside to do the actual task. Would everyone grab a bucket to get water and bring it back to the drum? Hopefully, one of the students will suggest the assembly line approach. If not, you may lead them into this idea. If the situation lends it, it may be a profitable experience to let the students haul water on their own, taking each bucket to the water source, filling it and then carrying it to the drums. Then have them repeat the activity using the chain gang and see how the time and effort compares. When the task is completed, ask the students how long they think this water would last if one person were to use it for drinking, bathing, and anything else in their lives that required water? After discussion, tell the students the water would only last one day for one student.

DISCUSSION:

1. Do you think people would use less water if they had to haul it daily?
2. What habits would people change? Are these conservation methods?
3. Discuss ways people use water indirectly (manufacturing, industry, fast foods, slaughtering houses, etc.).
4. Discuss benefits of working together. Does this conserve anything? (Figure out how much water the class uses, family, school, town, etc.)
5. What can we do with the water now that it has been

put in the drums? (Water trees, grass, put it back in the pond, purify and drink, etc.)

6. If you dump the drums towards the pond, will it cause any problems? (The runoff can wash soil to the pond; soil is the greatest water pollutant.) What would it be like if several classes in a row were to use the same area?

7. Discuss consequences of flooding if it were to run down a slope with loose soil.

FOLLOW-UP ACTIVITY:

Choose one of the methods of water disposal that the class discussed. Let them make the decision, then empty the barrels.

After this activity, compare how we obtain our water today and how it was obtained in the past. This could lead into a discussion of the water cycle. The water we drink today could be the same water consumed by a dinosaur millions of years ago.

TITLE:	Constructing a Contour Map
CONCEPT:	Contour lines connect points of equal elevation.
PURPOSE:	To allow students to better understand the function of contour lines.

MATERIALS:
plastic dish pan
20" x 20" sheet of Plexiglass
plaster of paris or plasticine model of a mountain
black grease pencil

PROCEDURE:

1. A simple model of a mountain can easily be made by fashioning a thin layer of plasticine modeling clay over a supporting wad of newspaper. A more permanent model can be made by using plaster-of-paris instead of the plasticine. The model should be made to fit within the limits of a plastic dish pan.

2. With a felt tipped marker or the black grease pencil, mark a depth scale (2 cm intervals) on the inside wall of the dish pan.

3. Put the model in the pan and add water to a depth of 2 cm. (It may be necessary to color the water so that you can see it better.)

4. Place the sheet of Plexiglass over the top of the dish pan and carefully trace the "shoreline" where the water contacts the mountain (island).

5. Remove the Plexiglass and add another 2 cm of water.

6. Repeat Step 4. Continue this procedure until the mountain has been covered by water and your contour map of the mountain is complete.

TITLE:	Stop That Leak!
CONCEPT:	We cannot afford to waste our natural resources.
PURPOSE:	To help students learn that small wastages over long periods of time can add up to large amounts of natural resources and money.

MATERIALS: measuring cup
wrist watch or clock

PROCEDURE: Find a leaky faucet at home or at school. By using a measuring cup and watch, calculate the amount of water wasted in one hour, one day, one month, one year. Using the cost per 100 cu. ft. (or rate established by the local water department), calculate the financial cost of the leaky faucet. Expand the calculations by the total number of leaky faucets found in the school and/or in homes of your classmates.

DISCUSSION:

1. What have students done to reduce wasted water at school or at home?

2. Suggest to proper authorities that continuously running drinking fountains could be replaced by more economical ones.

TITLE:	Erosion with the Stream Table
CONCEPT:	Running water on unprotected, sloping land causes erosion.
PURPOSE:	To teach students the effects of running water on sloping, unprotected soil.

PROCEDURE:

1. Arrange the stream table (see "How to Build a Stream Table" in this chapter).
2. Spray water on the upper 1/4 of the stream table allowing the water to seek its own path to the bottom of the slope.
3. Observe the different rates the water cuts into the different types of soil.

   Question: Does the water follow a straight path to the bottom or does it tend to meander (me-an'-dar)?

   Question: If the "stream" meanders, can you explain why?
4. Change the height to which the upper end of the stream table is elevated. See what effect this has on the erosion.
5. Alter the arrangement of the soil types and observe how this affects the rate of erosion.
6. At a set slope, have the students think of ways to cut down or eliminate erosion.

HOW TO BUILD A STREAM TABLE

A simple, outdoor stream table can be built rather easily. All you will need are some boards, a hammer, saw, nails, small pan, and 3 or 4 bricks. The dimensions of the table may vary due to available materials, as long as the bottom and sides are the same length and the ends are the same width as the bottom.

Cut a small opening in the center of the bottom end so that the water can run out.

Dirt, sand, and pebbles can be spread over the bottom at random.

An aquarium water pump with hose could be used to recycle the water.

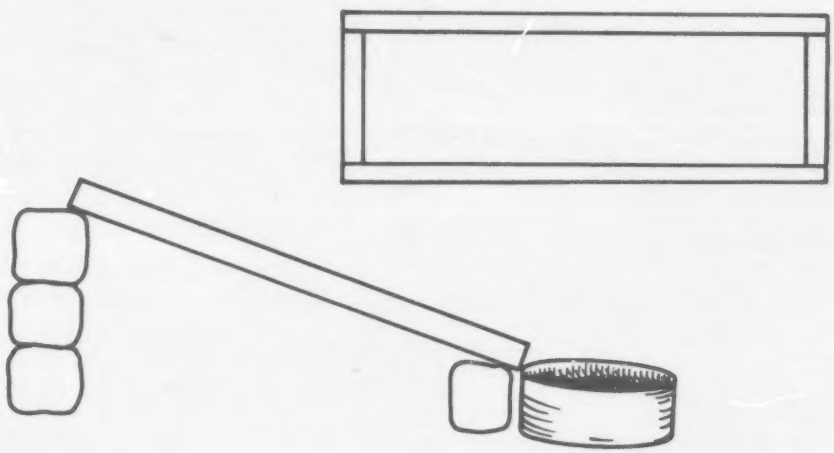

Figure 11

TITLE:	Using a Stream Table to Study Sedimentation (see "How To Build a Stream Table" in this chapter)
CONCEPT:	Sedimentary rocks are formed as a result of erosion and sedimentation.
PURPOSE:	To help students better understand sedimentation.

MATERIALS:

stream table
concrete blocks
soils of different textures
garden hose with sprinkler attached
shovel

PROCEDURE:

1. Using concrete blocks for support, elevate one end of the stream table and fill it with layers of different types of soil. Use gravel, coarse sand, fine sand, silt, loose clay soil, and good garden soil. Layer these in any order.

2. Using a shovel, scoop out a catch basin at the lower end of the stream table. This should be about four feet across and have a sloping bottom with the deepest part (about 12 inches) opposite the end of the stream table.

3. Using a garden hose with spray nozzle attached, spray the upper 1/4 to 1/3 of the stream table and allow the water to run freely into the catch basin. Continue running water until the catch basin is full.

4. The next day dip out most of the water from the catch basin (being careful not to disturb the material on the bottom) and repeat part 3 above. Continue this procedure until the water has eroded a channel to the bottom of the stream table.

5. After most of the sediment has settled out, dip as much water from the basin as you can without disturbing the bottom material. Allow the rest to dry naturally.

6. When the sediment has adequately dried, use a knife or similar device to cut vertical slices from the bottom material.

7. Have the students make observations concerning the layering, sorting, and thickness at different depths

of the sedimentary material.

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TITLE:	Stable vs. Unstable Air
CONCEPT:	Air is said to be stable if a displaced parcel of air will always return to its original position.
PURPOSE:	To give the student insight into how our atmosphere works.

BACKGROUND INFORMATION:

Stable Air: Air is said to be stable if a displaced parcel of air will always return to its original position. In the experiment below, what would happen to the mothball if you tried to suspend it in water before adding the vinegar? It would sink right back to its original position, the bottom -- just like stable air.

Neutrally Stable Air: Air is said to be neutrally stable if a displaced parcel of air is so similar to its environment that, like the suspended mothball, it remains where placed.

Unstable Air: When a parcel of air is displaced and continues to move in the direction of its displacement, the atmosphere is said to be unstable. Unstable air, like the rising mothball, moves away from its original position.

MATERIALS:

drinking glass, about 2/3 full of water
4 mothballs
baking soda
vinegar

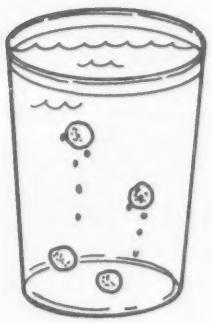
PROCEDURE:

Shake about one-half teaspoon of baking soda into the water and stir until dissolved. Drop the mothballs into the glass. Obviously each mothball sinks to the bottom. Now add a little vinegar to the glass. The mothballs begin to rise. Some may remain suspended in the water for a while but eventually, all will reach the top, fall back to the bottom of the glass, and in due time, bob up again.

The vinegar and soda interact to form carbon dioxide. When bubbles of the gas attach themselves to a mothball, the mothball becomes a little bigger and lighter than before --in other words, less dense. To remain suspended in the water, the density of the bubble -- enlarged mothball, must equal the density of the water. Eventually, when the mothball acquires enough bubbles and is lighter than the water, the mothball will rise to the top.

Parcels of air in the troposphere act very much like these

mothballs, sometimes staying put, sometimes rising, sometimes sinking, depending on how the density of the parcel compares to the density of the surrounding air.



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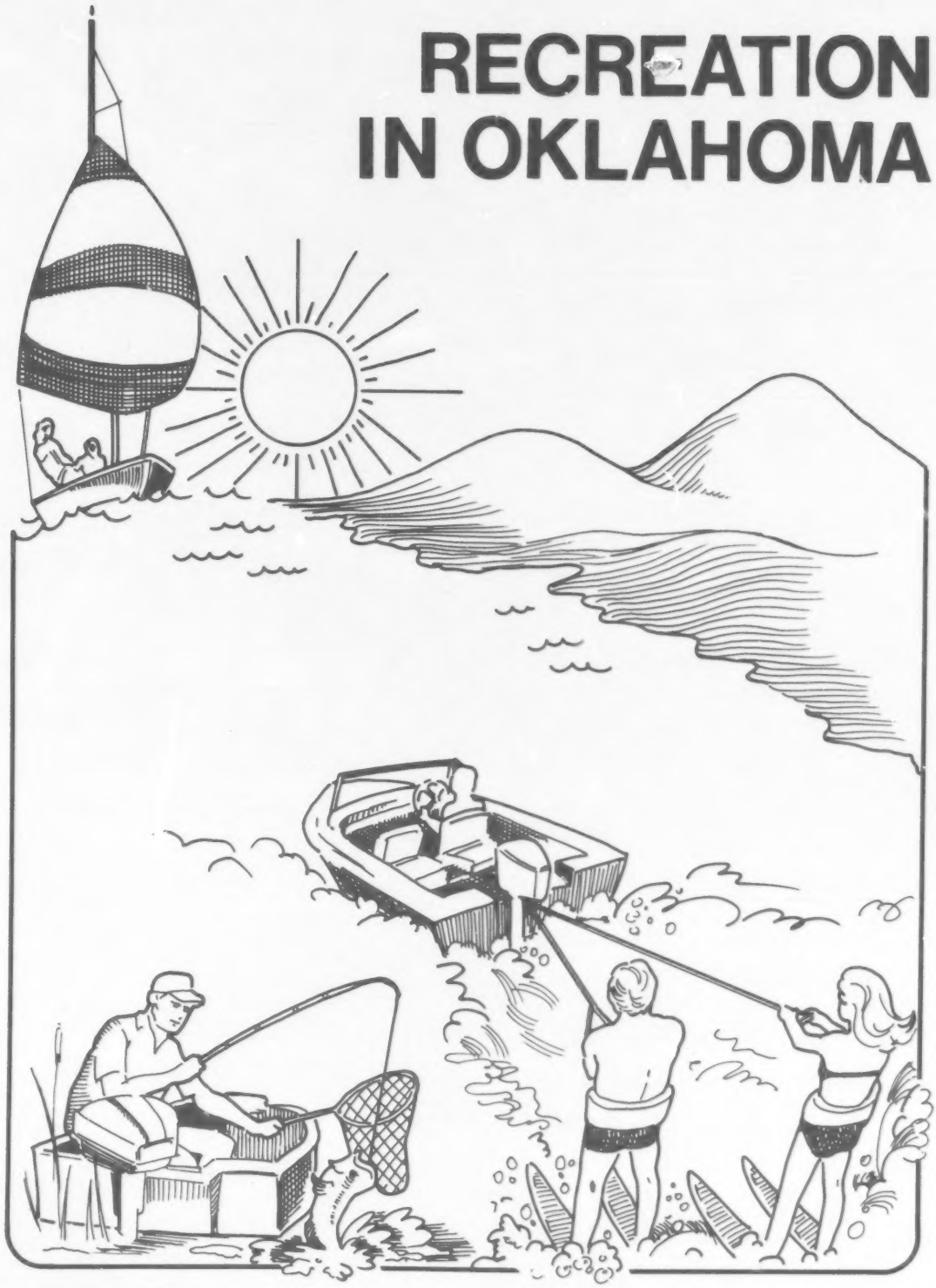
RECREATION IN OKLAHOMA



TITLE:	Leaf Printing
CONCEPT:	Materials in nature can be used for art forms.
PURPOSE:	Students can learn to use leaves without destroying limbs of the tree while creating their art projects.

MATERIALS:
leaves
printing ink or textile ink
paper, cloth, etc.
rollers for spreading ink
plates, glass, or a flat surface for rolling ink

PROCEDURE:
Cover area with old newspapers. Collect leaves and lay on table vein side up. Pour small amounts of ink onto flat surface. Roll leaves with ink. Turn leaves over and place vein side down on surface desired to be printed. Cover with a clean sheet of paper and again roll over the leaves. Remove paper and leaves.

Veins, texture, lobes stem position, and leaf shape can be studied from these printings.

Triangle pieces of fabric can be printed to look like scarves.

Make place mats or pictures.

Leaves arranged in a circle of five can be made to resemble flowers.

Make leaf collages.

Salt Plains Reservoir, Foss Reservoir, Lake Carl Etling, Fort Supply Reservoir, and Lake Ponca.

The Oklahoma Tourism and Recreation Department operates 35 state parks, 27 recreation areas, and 14 historic monuments and museums. In addition, numerous wildlife areas, hunting preserves, and recreation sites are operated by others, as well as restorations by the State Historical Society. Many federal installations are contributing to the outdoor recreation establishment, particularly the U. S. Army Corps of Engineers, the National Park Service, and the National Forest Service. Also, many local, semi-public, and private programs and facilities function for the benefit of the recreationist. In total, outdoor recreation resources in Oklahoma include parks, monuments, historic sites, recreation areas, lakes and reservoirs, wilderness areas, and national forests. Together they provide the basis for outdoor loving Sooners and their friends to partake of the state's outdoor recreational offerings.

Memorial at Claremore attracts thousands of visitors. Green Country contains a multitude of lakes, including Lake Eufaula, Lake Tenkiller, Wister Reservoir, Fort Gibson Reservoir, Keystone Reservoir, Heyburn Lake, Hulah Reservoir, Spavinaw Lakes, Lake Hudson, and Grand Lake O' the Cherokees.

KIAMICHI COUNTRY

Kiamichi Country, in the southeastern corner of the state, is culturally and traditionally linked both with Oklahoma's Indian heritage and with the Old South. Interesting spots for visitors include the winter circus headquarters at Hugo, the old Spencer Academy near Sawyer, where "Swing Low, Sweet Chariot" was written, the Old Chief's House near Swink, the Governor's Mansion east of Broken Bow, and the Wheelock Mission Church west of Idabel. Water fun in Kiamichi Country includes Broken Bow Reservoir, Pine Creek Reservoir, Hugo Reservoir, Clayton Lake, and Eufaula Reservoir.

RED CARPET COUNTRY

Oklahoma's historic Red Carpet Country lies in the northwestern section of the state. Alabaster Caverns near Freedom is an underground wonderland. Visitors will enjoy the preserved Sod House near Cleo Springs and will find fascination at Bee City west of Erick. Other historical attractions include the Black Kettle Museum at Cheyenne and the Seay Mansion at Kingfisher. Visitors are surprised to see huge sand dunes at Oklahoma's Little Sahara Desert area near Waynoka. Excellent water recreation may be found in Red Carpet Country at Canton Reservoir, Great

2
B.M
1.0
1.1
1.25
1.4
1.6
2.8
2.5
3.2
2.2
3.6
2.0
4.0
1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

FUN COUNTRY

At the southern edge of Oklahoma is exciting Fun Country. Visitors will enjoy beautiful Turner Falls near Davis and will marvel at the unusual outcroppings of rocks seen in the Arbuckle Mountains. Historical sights include the Chickasaw Indian Capitol at Tishomingo, Fort Washita east of Madill, and the Robert S. Kerr cabin near Ada. There's plenty of lake action in Fun Country with the fabulous Lake Texoma, plus Lake Murray near Ardmore, Lake of the Arbuckles near Sulphur, and Lake Atoka.

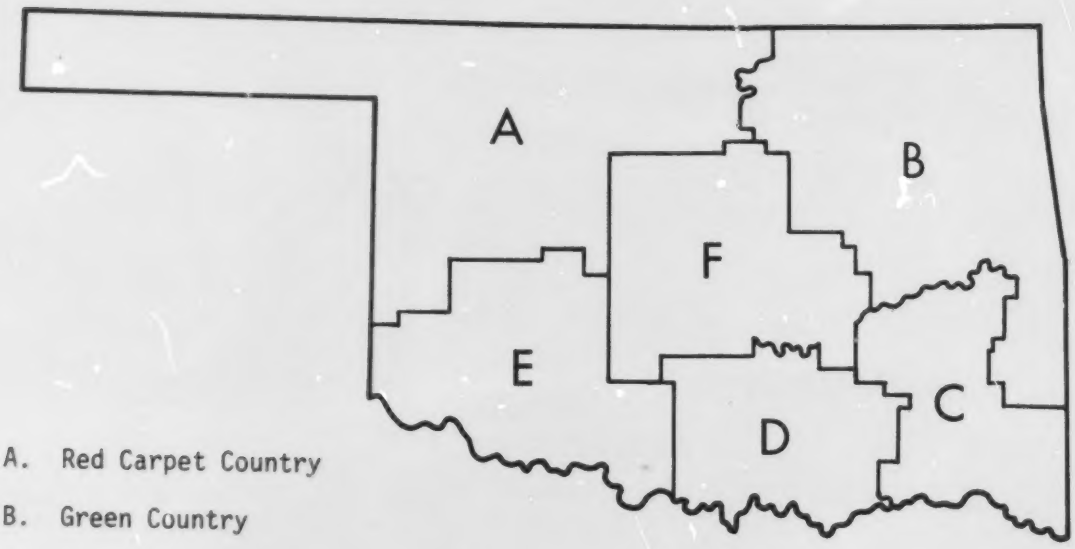
GREAT PLAINS COUNTRY

Great Plains Country is in southwestern Oklahoma and features a great many scenic and historical attractions. In the Fort Sill Museum complex near Lawton, visitors can see the Cannon Walk and Old Stockade. Indian City USA and the Southern Plains Indian Museum are both located near Anadarko. Mount Scott in the Wichita Mountains is the highest point in southwestern Oklahoma, and has paved road all the way to the top. Water recreation in Great Plains Country includes Lake Altus, Fort Cobb Reservoir, Lake Ellsworth, and Lake Lawtonka.

GREEN COUNTRY

Oklahoma's scenic Green Country is in the northeastern part of the state. A highlight of Green Country is the Talimena Skyline Drive across the Winding Stair Mountains between Talihina, Oklahoma and Mena, Arkansas. The Cherokee Cultural Center and Tsa-la-gi Pageant are located near Tahlequah, the old Cherokee Tribal Capitol. Pawnee Bill's home west of Pawnee contains mementos of the great showman's life. The Will Rogers

OKLAHOMA COUNTRIES



A. Red Carpet Country
B. Green Country
C. Kiamichi Country
D. Fun Country
E. Great Plains Country
F. Frontier Country

Figure 12

FRONTIER COUNTRY

Oklahoma's fabulous Frontier Country is a 12-county region in the geographical heart of the state. In Oklahoma City, the visitor will find the National Cowboy Hall of Fame, the State Capitol Complex with producing oil wells on the grounds, the Oklahoma Historical Society Museum, the outstanding Oklahoma City Zoo, and Oklahoma Heritage House. The largest Masonic Consistory in the nation is located at Guthrie. Territory Town Museum is west of Okemah on Interstate Highway 40. Frontier Country includes some excellent lakes, such as Thunderbird Reservoir, Lakes Overholser, Hefner, Draper, and Lake Carl Blackwell.

sibilities for maintaining these recreation areas? How do we insure best use of the land, and that our recreational activities have a positive, rather than negative, influence in the recreation areas?

Thus education evolves into a dual purpose, first, to educate regarding the importance of maintaining our recreational areas, and secondly to utilize these recreational areas in teaching about our natural environment. However, before we can utilize the outdoor recreation experience and our state and local parks to their best educational use, we must have an understanding of the inter-relationship between man and the land, the two essential components for recreation.

These chapters stress how man impacts the land. His influence creates many of the changes that occur in the environment, both positive and negative. How do these processes reveal themselves on the recreational setting?

In recreation, the land serves two purposes: preservation and use. Oklahoma's parks and recreational areas serve as depositories of the natural environment. A park in many cases is set aside as a museum of the land's natural state. However, in order for this land to be considered recreational land it must generate use. The basic problem of our parks is to preserve these areas while also allowing for their recreational use.

Oklahoma has six exciting and unique tourism "countries" -- Frontier Country, Fun Country, Great Plains Country, Green Country, Kiamichi Country, and Red Carpet Country. Each one is different, and each contains hundreds of interesting and exciting things to do and places to go.

vandalism. Utilizing recreation facilities as outdoor classrooms allows us to learn about the natural environment. Parks, nature preserves, and wildlife preserves provide first-hand contact with textbook topics.

Learning is often seen as a process which can only be accomplished in the formal classroom, however, many now advocate leisure and recreation as a learning process in itself. Work is being challenged as the central focus of life. Americans are more affluent, enjoy more leisure time, and are becoming more recreation-oriented than ever before.

Recreation must be recognized as an important part of the learning process. It has long been recognized as important in acquiring social and physical skills. There is now a growing trend to incorporate educational skills into the recreational experience. This has been demonstrated by an increase in the number of interpretive education and naturalist programs offered at our state parks, through the inclusion of diversified recreation curriculum in our schools (such as backpacking, mountain climbing, and sailing), and through utilization of the recreational setting to teach educational concepts.

There are many forms and varieties of recreation. For our purposes, we will concentrate on outdoor recreation, much of which transpires in our state and local parks.

Man's wise use of the land must be encouraged. As work weeks get shorter and incomes increase, already overburdened and overused lands will probably suffer increasing stress. And as energy prices rise, Oklahoma's parks and recreation areas will probably receive greater use as people vacation closer to home. Experience has shown that park areas have a very limited tolerance for people and cars. What are our respon-

cottages, and buildings on these lands. The seven core parks were Boiling Springs, Roman Nose, Quartz Mountain, Lake Murray, Beaver's Bend, Robber's Cave and Osage Hills. However, between the late 1930's and early 1950's, the state recreation programs did not receive recognition through legislative appropriations, and were, therefore, hampered by lack of funds for acquisition, site development, and operation and maintenance of recreation areas. But, more money began being appropriated in the 1950's for recreation. Many of the federal reservoir projects were being completed, and adjacent lands were acquired and developed into recreation facilities by both state and federal agencies. By 1956, Oklahoma had 13 state parks, one national park, a national forest, and four game and wildlife preserves.

Today, Oklahoma has more than 2,000 publicly-administered recreation areas covering over one million acres of land, nearly 3 percent of the state's total area. This does not include privately-administered recreation areas or major lakes and reservoirs.

Recreation may seem out of place as a chapter in an Outdoor Education Activities Guide, however, there is much to be learned from and about recreation. While it is impossible to detail all in this one chapter, there are two important concepts to be emphasized. They are:

1. Everyone should participate in some form of recreation.
2. Recreation facilities are excellent outdoor classrooms.

To the individual, a positive recreation experience is important in relieving stress, improving one's physical condition and providing a social outlet for entertainment. For the facility, positive use should be taught in order to avoid negative impacts such as overuse, littering, and

of relaxation had to be invented on the spot, but the settlers were more than equal to the task. Horse races and turkey shoots, square dances, singing bees, and rides in the surrey were enthusiastically enjoyed by young and old alike.

The abundance of wild fowl and game, while primarily a source of food, also served as sport for those who loved the chase. The offerings of lakes and streams were a haven of relaxation for the fishermen.

Later, in the early part of this century, when the raw edge of the frontier had been dulled by use, residents of the state's communities took their pleasure in such pursuits as cowpasture baseball, band concerts, Will Rogers' Rodeo, and visits to the wonderful 101 Ranch near Ponca City, or to Medicine Park near Lawton. Youngsters busied themselves with Sunday fishing, tote sack races, shoe races, and an occasional knocking down of a black wasps' nest, while their elders passed the time riding for pleasure -- on horseback, in a flivver, or, if you lived in Oklahoma City, in a streetcar bound for Belle Isle Lake. Community picnicking was, as now, the focal point of many an outing. The Hominy Indians were affording the spectator his first glimpse of professional football as they ranged far and wide to represent the young state in a most laudable manner, and initiate enthusiasm for the gridiron sport shared by so many Oklahomans today.

Although a developed park system was almost non-existent in Oklahoma prior to 1935, the economic depression created public work programs and state agencies which aided the development of state recreation areas. In 1937, a state agency was given authority to acquire, maintain, and control state parks, and to operate, rent or lease any or all concessions,

CHAPTER 3

RECPEATION IN OKLAHOMA

The U. S. national parks system was 100 years old in 1972. Since President Grant signed a bill in 1872 creating Yellowstone as the world's first national park, the system has increased to approximately 300 units consisting of parks, monuments, historic sites, recreation areas, wilderness areas, trails, and national seashores and lake shores. The unique national park concept has been one of the most successful and important projects of this country's recreation history, influencing the development of state park systems throughout the country as well as national park systems in over 100 other nations.

The recreational history of Oklahoma, like the rest of the nation, began long before any organized park system. Recreation was present with the early explorers who combed the region. It was present with the Indian tribes that roamed the prairies. It was present with Oklahoma's early settlers.

In 1889, Congress passed legislation authorizing the opening of unassigned lands in Oklahoma, and on April 22, some 50,000 people lined the borders of the new Oklahoma Territory. At noon, a signal by cannon shot authorized the historic land rush of '89. By nightfall, tent cities had sprung up from the prairies, and six counties were born. Oklahoma City became a city of 10,000 in a single day.

In the early days of the state's development, amusements and methods

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TITLE:	What Makes Up A Recreation Area?
CONCEPT:	Recreation sites require an understanding of the relationship among plants, animals, land, and water.
PURPOSE:	Student groups will design a recreation site incorporating aspects of the environment such as plant life, animals, recreational opportunities, etc.

PROCEDURE: Committees of five or six students will design one of the following recreation sites. Each site should be visually presented to the class at the completion of the project.

a. city park
b. nature trail
c. overnight camp area
d. two-acre plot (any use)
e. farm pond or wildlife plot

FOLLOW-UP: Discuss how a person feels after designing an area and then someone removes a tree or crushes or scribbles on their project.

Discuss how area such as parks, back yards and school grounds are like recreation areas. How are they different from overnight camping areas?

NOTE: Recreation area should provide the least amount of stress on the environment.

TITLE: Exercise in Map Reading

CONCEPT: Reading a map is easy.

PURPOSE: This activity is designed to help the students learn how to use a map for the purpose of location of different sites.

MATERIALS: road map of Oklahoma

PROCEDURE:

1. Give students road map of Oklahoma

2. Have students locate each of the following cities on the map then describe where each is within the state.

   a. home town
   b. Beggs
   c. Oklahoma City
   d. Tulsa
   e. Ames
   f. Waurika
   g. Grove

3. Talk about coordinates and illustrate on the map how they are used.

4. Have the students use coordinates to find the following cities:

   a. Anadarko
   b. Lindsey
   c. Bristow
   d. Hooker
   e. Miami
   f. Smithville

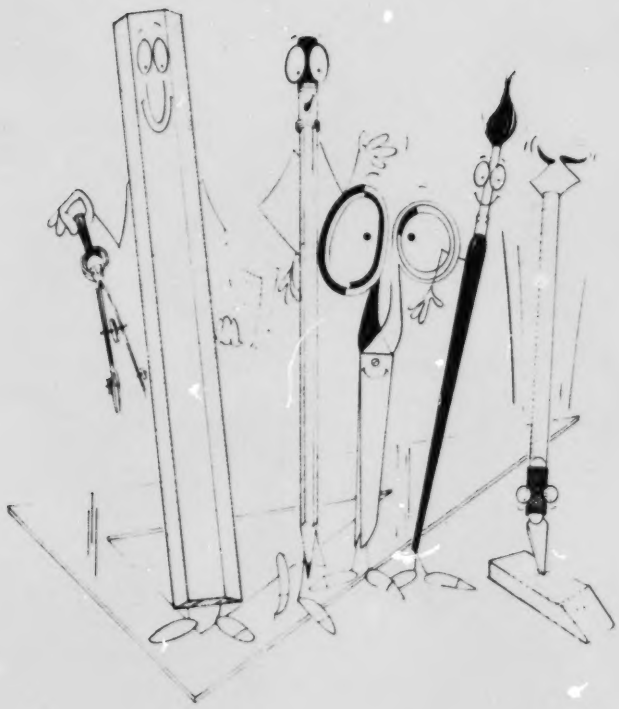
5. Ask the students if the cities were easier to find using the coordinates given. Why do maps have coordinates?

6. a. Have the students estimate the distance from Oklahoma City to Tulsa and from Ada to Wilburton using the scale of the map.
   b. Now point out the mileage figures on the map and have the students use the mileage figures to find the distance from Oklahoma City to Tulsa and Wilburton to Ada.

7. Which method (using the scale or mileage figures) was more accurate?

8. Point out the legend of the map. Have the students find and list coordinates and mileage from one wilderness area, national wildlife refuge, and state park.

9. Have students list reasons for maps to contain legends, scales, mileage figures, and coordinates.



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TITLE:	Scavenger Hunt
CONCEPT:	We can find many different things in our environment.
PURPOSE:	To awaken the student's awareness to detail around him.

MATERIALS:

collecting bags
5 different leaves
bag full of trash
one drawing of animal foot print
2 different rocks
2 different textures
one sound from nature
a trace from an animal
one material that can be used to build a nest
one seed
2 simple shapes

PROCEDURE:

The scavenger hunt is great for awakening one's awareness to detail. Depending on the size of the group, have the participants divide into groups of 2, 3, or 4 people. Give them about 20 minutes to collect their things. When all the groups have returned, let them share with the others what they have found. You may have to elaborate a bit on some of the articles listed, depending on the age and sophistication of the people you are working with. Also, make up your own list for the hunt or to make changes in this list.

EACH GROUP WILL COLLECT EVIDENCE OF THE FOLLOWING PHENOMENA:

1. A simple machine
2. Three simple shapes
3. A sweet taste and a sour taste in nature
4. A pleasant and an unpleasant smell in nature
5. A trace from an animal
6. Three primary colors and two secondary colors
7. Three different textures
8. One sound from nature
9. An example of nonbiodegradable litter being degraded
10. Something older than you are and something younger
11. A producer, a consumer, and a decomposer

TITLE:	Oklahoma State Parks
CONCEPT:	State parks in Oklahoma provide outdoor educational facilities.
PURPOSE:	To identify certain outdoor sites with specific outdoor concepts. List can be expanded as parks become familiar.

PROCEDURE: Choose the letter of the state park or recreation area and place it in front of the area that best describes the area's unique characteristics. NOTE: Answers may be used more than once.

____ 1.	77 ft. waterfall fed by mountain streams	a.	Turner Falls
____ 2.	12 ft. high monument-like stone bearing Runic alphabet markings dating to 1012 A.D.	b.	Ouachita
____ 3.	Oklahoma's only national forest	c.	Little Sahara
____ 4.	Sand dunes	d.	Alabaster Caverns State Park
____ 5.	Site of many graves of prehistoric people of Oklahoma	e.	Heavener Runestone State Park
____ 6.	Natural bridge formed by stream erosion undercutting gypsum and rising 150 feet above the floor of Cedar Canyon	f.	Stovall Museum
____ 7.	Prehistoric animals, natural history, and Oklahoma archaeology found here	g.	Talimena
____ 8.	Skyline drive in the Ouachita Mountains	h.	Spiro Mounds State Park
____ 9.	Selenite crystals found here	i.	Washita Mountains Wildlife Refuge
____10.	World's largest gypsum cave	j.	Great Salt Plains
____11.	National wildlife refuge for buffalo and longhorns	k.	Beavers Bend State Park
____12.	Cave myotis, Western Big-Eared bat and Mexican Treetail bat found here		
____13.	Forest Heritage Center		

KEY

1.	77 ft. waterfall fed by mountain springs	TURNER FALLS
2.	12 ft high monument-like stone bearing Runic alphabet markings dating to 1012 A.D.	HEAVENER RUNESTONE
3.	Oklahoma's only national forest	OUACHITA
4.	Sand dunes	LITTLE SAHARA
5.	Site of many graves of prehistoric people of Oklahoma	SPIRO MOUNDS STATE PARK
6.	Natural bridge formed by stream erosion undercutting gypsum and rising 150 feet above the floor of Cedar Canyon	ALABASTER CAVERNS STATE PARK
7.	Prehistoric animals, natural history, and Oklahoma archaeology found here	STOVALL MUSEUM
8.	Skyline drive in the Ouachita Mountains	TALIMENA
9.	Selenite crystals found here	GREAT SALT PLAINS
10.	World's largest gypsum cave	ALABASTER CAVERNS STATE PARK
11.	National wildlife refuge for buffalo and longhorns	WASHITA MOUNTAINS WILDLIFE REFUGE
12.	Cave myotis, Western Big-Eared bat, and Mexican Treetail bat found here	ALABASTER CAVERNS STATE PARK
13.	Forest Heritage Center	BEAVERS BEND STATE PARK

TITLE:	Abuse of a Recreation Site
CONCEPT:	Some people misuse recreation sites.
PURPOSE:	Students will distinguish between respect and lack of respect of a recreation site.

PROCEDURE: Evaluate the condition of your favorite recreational area. (School ground, park, soccer field, state park, etc.) Rate it on a 1 - 10 basis, 10 being excellent, 1 bad. Rate each of the categories and then take the average.

General area - - looking for problems on the site

broken glass	excellent	10 9 8 7 6 5 4 3 2 1	bad
broken windows		10 9 8 7 6 5 4 3 2 1	
play equipment in good shape		10 9 8 7 6 5 4 3 2 1	
park benches in good shape		10 9 8 7 6 5 4 3 2 1	
grass mowed		10 9 8 7 6 5 4 3 2 1	
sidewalks		10 9 8 7 6 5 4 3 2 1	
bathroom facilities		10 9 8 7 6 5 4 3 2 1	
presence of graffiti		10 9 8 7 6 5 4 3 2 1	
broken shrubs		10 9 8 7 6 5 4 3 2 1	
use of litter containers		10 9 8 7 6 5 4 3 2 1	
grass near sidewalk		10 9 8 7 6 5 4 3 2 1	

_____average number on rating

If area was used for overnight camping, include an evaluation of the camping facilities, availability for multiple activities such as swimming, boating, nature hikes, trails, and hook-ups.

Would you want to take your family to this spot? Why or why not? How would you like to see this recreation site changed?

ALTERNATE ACTIVITY:

Make slides of a recreation area and have students evaluate the area according to a scale of 1 to 10, bad or excellent.

Have students bring photographs of camping trips and look at these in terms of facilities available and how the area had been used or misused prior to the family arriving at the camp site.

TITLE:	How Decomposition of Trash Affects Recreation Sites
CONCEPT:	Changes occur when trash is mixed with soil and moisture.
PURPOSE:	The students will discover the rate of decay and how lack of decay will influence the environment.

MATERIALS:

loam soil
tray
medicine dropper
glass dishes (transparent), may be petri dishes or, as a substitute, baby food jars
masking tape
metric ruler
scissors

non-food litter materials:
facial tissue
balloon
cellophane
cloth
bottle cap
plastic cup
waxed paper
cardboard
aluminum foil
gum wrapper

PROCEDURE:

1. Place equal amounts of loose soil in each see-through container.
2. Cut a piece about 1 cm square from each of the above non-food materials.
3. Cover litter samples with soil, being careful not to pack soil down. The litter sample should be visible through the bottom of each dish.
4. Add water to the soil with a medicine dropper.
5. Make the soil moist but not muddy.
6. Cover dishes, place lid over jars and label with date of experiment and type of litter.
7. Put in a safe place and observe the litter samples through the bottom of the dish every other day for two weeks.

8. Look for changes in color, size, shape, sign of moisture and mold growth, and texture.

9. At the end of two weeks examine your data.

10. Compare predictions with your observations.

DISCUSSIONS: Which materials decay faster in soil?

Which of the materials showed litter decay?

Does this indicate why litter is a problem?

Are disposable items affecting our environment?

Suggest solutions for this problem.

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TITLE:	Sun Prints
CONCEPT:	Sun prints are fun to make.
PURPOSE:	The purpose of this activity is to become more aware of shapes, textures, and colors of nature objects.

MATERIALS:

2 sheets of diazo paper per student
wide-mouth gallon jar with lid
5" diameter sponge or foam pad 3/4" - 1" thick
plastic grate
ammonia
clear plastic wrap
11" X 14" cardboard squares

PROCEDURE:

Preparation of materials:

1. Pour enough household ammonia into each gallon jar to cover the bottom.

2. Place the sponge or foam pad in the bottom of the jar.

3. Place the plastic grate on top of the sponge. Place lid on jar and cover jar with grocery bag to prevent sunlight from penetrating jar (if classroom is outside).

INTRODUCTION:

In this activity you are asked to go on a scavenger hunt and collect several nature items. While on the hunt, you can observe and become aware of the different shapes, textures, and colors of the nature objects around the camp area.

When you return to the classroom photographic sun prints will be made of the items collected.

SUN PRINT SCAVENGER HUNT:

Each student should find:

1. A leaf from a tree that loses its leaves in the winter time (deciduous (dee-sid'-u-us))
2. A leaf from a tree that does not lose its leaves in the winter time (remains green - coniferous (kon-if'-er-us))
3. Two simple shapes
4. Two types of grassy plants (including tops)

5. Two objects with different textures

Return to your teacher's area. Combine your objects into an interesting arrangement. You needn't use all of your objects. Shortly, you will place this arrangement on your blue print paper.

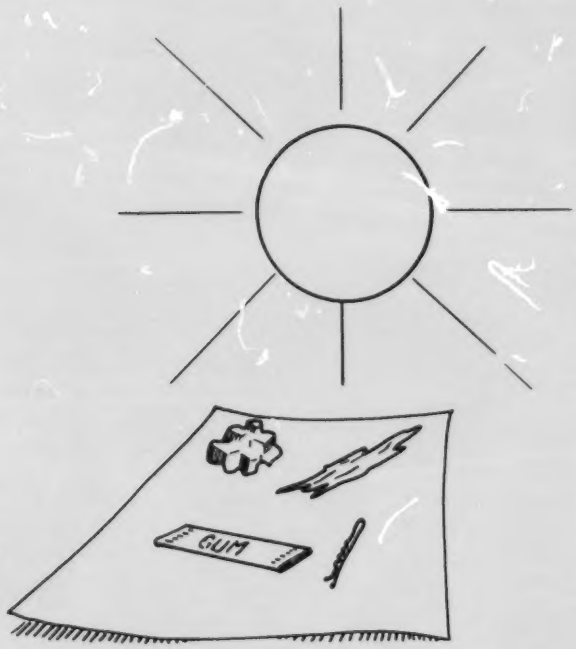
MAKING THE PRINT:

1. In the shade of your body, remove one sheet of diazo paper and arrange the items on the paper. Cover the objects with clear plastic wrap to hold the objects flat.

2. Expose the paper and objects to sunlight for 10-30 seconds or until the paper turns white.

3. Clear the objects from the paper in the shade of the classroom and place the paper into the ammonia jar. Put the lid on the jar and cover the jar with the grocery sack.

4. If the print takes too long to develop, shake the jar and/or turn the foam pad over. If this does not help, add more ammonia.



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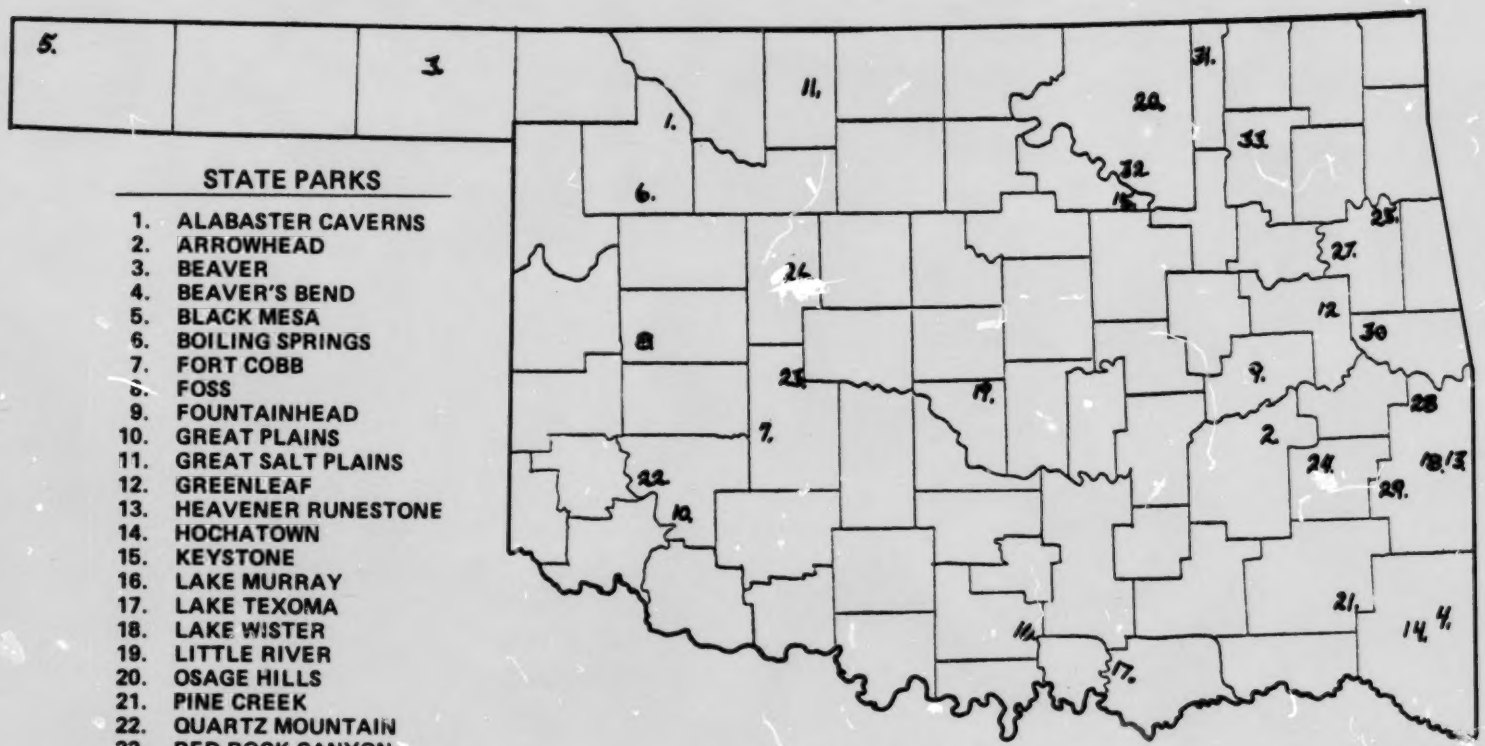
TITLE:	Recreation Areas of Oklahoma
CONCEPT:	Recreation areas are located close to our natural resources.
PURPOSE:	This activity will show the relationship between the location of recreation areas and that of our natural resources.

MATERIALS: map of recreation areas of Oklahoma
map of Oklahoma (road map will do if it includes lakes, streams, and mountains)

PROCEDURE: Give the students the map of the recreation areas and also a road map of Oklahoma.

1. Have students look at the maps for areas that "stand out".
2. In what region (North, South, East, West or Central) do most recreation areas occur?
3. Name all the lakes you can find and give their location.
4. In what region of Oklahoma do lakes generally occur?
5. Name all of the streams and rivers you can find and give their location.
6. In what region of Oklahoma do streams and lakes generally occur?
7. Locate the mountain ranges in Oklahoma and give their location.
8. In what region of Oklahoma do the mountains generally occur?
9. Compare the location of lakes in Oklahoma to the availability of recreation areas.
10. Compare the location of streams and rivers in Oklahoma to the availability of recreation areas.
11. Compare the location of mountains in Oklahoma to the availability of recreation areas.

OKLAHOMA STATE PARKS



STATE PARKS

1. ALABASTER CAVERNS
2. ARROWHEAD
3. BEAVER
4. BEAVER'S BEND
5. BLACK MESA
6. BOILING SPRINGS
7. FORT COBB
8. FOSS
9. FOUNTAINHEAD
10. GREAT PLAINS
11. GREAT SALT PLAINS
12. GREENLEAF
13. HEAVENER RUNESTONE
14. HOCHATOWN
15. KEYSTONE
16. LAKE MURRAY
17. LAKE TEXOMA
18. LAKE WISTER
19. LITTLE RIVER
20. OSAGE HILLS
21. PINE CREEK
22. QUARTZ MOUNTAIN
23. RED ROCK CANYON
24. ROBBER'S CAVE
25. ROCKY FORD
26. ROMAN NOSE
27. SEQUOYAH
28. SPIRO MOUNDS
29. TALIMENA
30. TENKILLER
31. WAH-SHA-SHE
32. WALNUT CREEK
33. WILL ROGERS

Figure 16

WORD SEARCH

OKLAHOMA STATE PARKS

This word search contains the names of the Oklahoma State Parks. See how many you can find, then locate them on the map.

Q P F O U N T A I N H E A D I S E

U I W A H S H A S H E C F H N T M

A N O Y N A C K C O R D E R U E W

R E O S A G E H I L L S E S K X B

T C R O B B E R S C A V E P E O O

Z R O C K Y F O R D A Z G U Y M I

M E M U R R A Y I C R A Z Y S A L

O E A B E A V E R S B E N D T T I

U K N G R E E N L E A F E D O E N

N O N F O R T C O B B A B Y N N G

T Q O K B S E Q U O Y A H F E K S

A M S S A L T P L A I N S P R I P

I G E B L A C K M E S A M M Y L R

N E A R R O W H E A D F O S S L I

S L I T T L E R I V E R L E T E N

A E T A L I M E N A W I S T E R G

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TITLE: Oklahoma's Habitats - Part 1

CONCEPT: Oklahoma has wetlands, forests, and prairies that support a variety of wildlife.

PURPOSE: Upon completion of this activity students will:

1. be able to name the different habitat types that exist in Oklahoma;
2. be able to name the types of habitat that occur near their own towns and the animals which occupy each of these.

MATERIALS: three maps for each student (on the following pages):

1. showing forests in Oklahoma
2. showing prairie habitats
3. showing Oklahoma's major lakes and rivers

crayons or map pencils

PROCEDURE:

1. Duplicate and distribute copies of Map #1, forests of Oklahoma. Using the map key, guide the students in locating the three main types of forests in Oklahoma. Ask such questions as:

   a. Which half of the state contains more forested area? (Eastern)

   b. Can you think of any reasons why most of Oklahoma's forests are in the eastern portion? (Rainfall, more suitable soils)

   c. Is your school and town in a forested area of the state?

   d. If so, what general forest type exists there?

   Students should know that trees will also be found along water courses in the "open" or unforested areas of Oklahoma.

2. Distribute Map #2, which shows sections and types of native prairie in Oklahoma. Provide students with appropriate information from background so they will

realize very little of the native prairie exists today as it did 100 years ago.

Using the map key, locate the various prairie sections of the map. By comparing Maps #1 and #2, the students should notice much of the section designated as tallgrass prairie is actually blackjack and postoak forest. Tallgrass prairie exists in the part of that section which is not forested.

Ask the students to indicate the approximate location of their county.

a. Is your county located in any of the prairie sections of Oklahoma?

b. Are you familiar with any grassland not used for cropland or not heavily grazed, but rather, allowed to grow "naturally"?

Let students know there is a gradual transition between forests and prairies. The line is not distinct between the two.

3. Distribute Map #3, Oklahoma's major lakes and rivers. Locate these lakes and rivers on the map.

a. Are any of these lakes or streams near you?

b. Are you familiar with other streams, lakes, ponds, etc., in your home county?

Students should use crayons or map pencils to color in the areas of forest and prairie on Maps #1 and #2. Color the different habitats distinctively.

OKLAHOMA'S FORESTS

Figure 14

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Recreation

PRAIRIE GRASSES OF OKLAHOMA

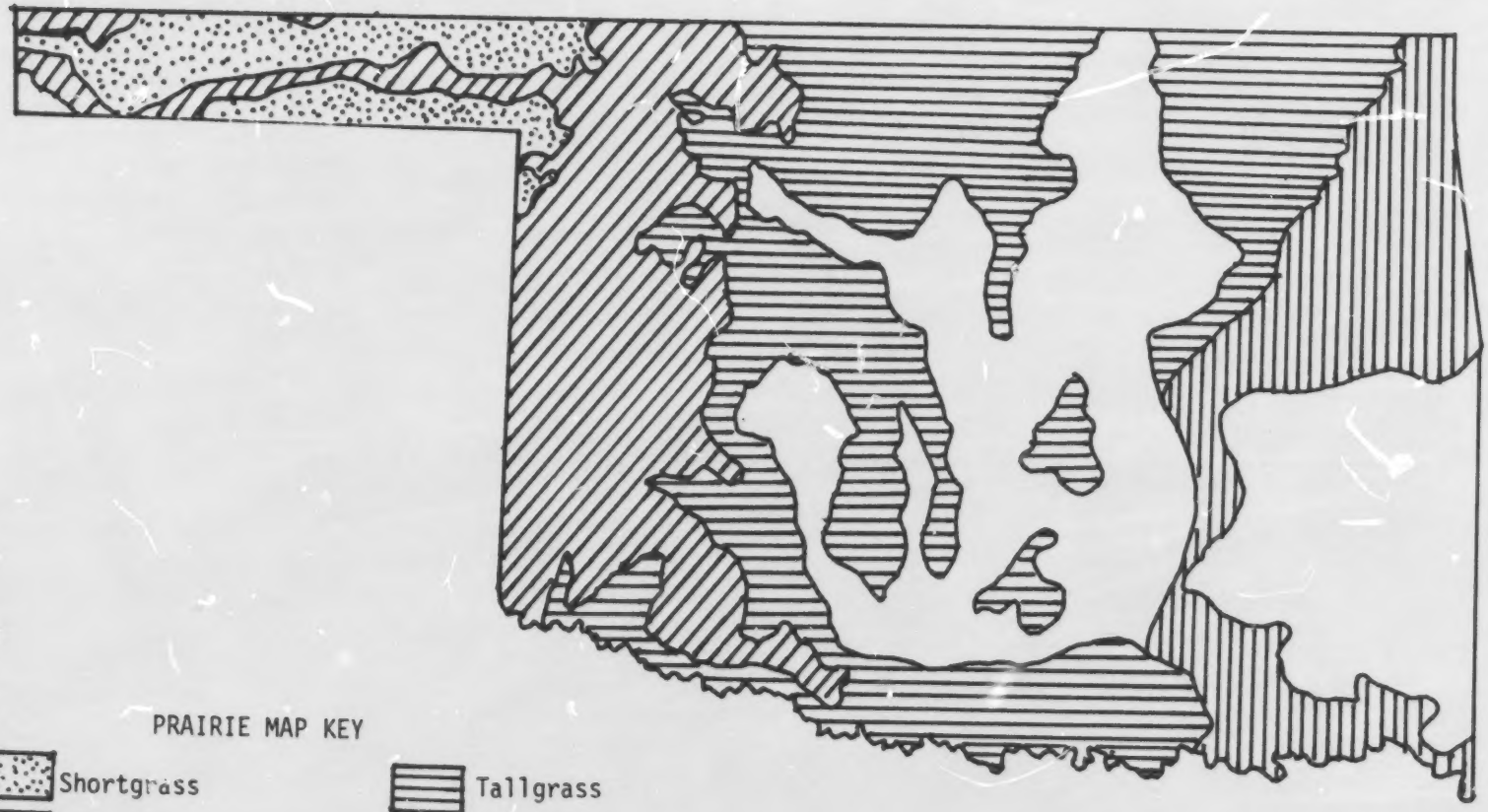

Figure 15

Figure 16

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TITLE:	Oklahoma's Habitats - Part 2
CONCEPT:	Oklahoma has wetlands, forests and prairies that support a variety of wildlife.
PURPOSE:	Upon completion of this activity students will: 1. be introduced to animal species that live in Oklahoma's major habitat types; 2. learn to look for specific information, take notes, organize into outline form and make a four-paragraph report.

MATERIALS:

pencil
paper
outline format (on page following activity)
resource books such as:
Sport Fish of Oklahoma*
Oklahoma Game Birds*
Oklahoma Mammals*
Golden Nature Guides

*Booklets available free of charge from the Oklahoma Department of Wildlife Conservation, P. O. Box 53465, Oklahoma City, Oklahoma 73152.

PROCEDURE:

Number slips of paper from one thru the number of students in your class. Students draw numbers. Let student with number one choose an animal from the following list. Continue until all animals on the list have been chosen.

FORESTS

Bobcat
White-tailed Deer
Fox Squirrel
Wild Turkey
Downy Woodpecker
Three-toed Box Turtle
Horned Owl

EDGE (Transition between woodlands and open areas)

Bobwhite
Cottontail Rabbit
Cardinal

PRAIRIES

Coyote
Buffalo
Prairie Dog
Prairie Chicken
Jackrabbit
Meadowlark
Bull Snake

PONDS AND STREAMS

Beaver
Bullfrog
Largemouth Bass

LAKES	STREAMS
Sand Bass (White Bass)	Raccoon
Striped Bass	Smallmouth Bass
	Blotched Water Snake

Each student should use such books as those listed under "materials" to gather information about the animal he has chosen. This "note gathering" should be organized into outline form as detailed on the following page.

After the outline is completed, the student should write a four-paragraph report from the information on his outline.

MY ANIMAL REPORT

NAME_____

NAME OF ANIMAL_____

I. DESCRIPTION OF ANIMAL

A.

B.

C.

D.

II. PREFERRED HABITAT

A.

B.

C.

III. PREFERRED FOODS

A.

B.

C.

D.

IV. RANGE IN OKLAHOMA

A.

B.

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TITLE: Saturated Habitat - - Study of Carrying Capacity

CONCEPT: The number of animals in an area is determined by the availability of food, water, and cover.

PURPOSE: Upon completion of this activity the student will be able to:

1. explain the meaning of carrying capacity;
2. compare a saturated solution with a wildlife habitat.

MATERIALS:
sugar
water
drinking glass
spoon

PROCEDURE: Fill the glass with water. Ask students what will happen if you stir in a spoonful of sugar. (It will dissolve.) Use the water to represent a particular wildlife habitat. The sugar will represent the wildlife population. Add a spoonful of sugar. Since you have already said the sugar will dissolve, you may infer from this that the habitat will carry the wildlife. Can you continue to add sugar (wildlife) and be certain that it will be dissolved (carried) by the water (habitat)? Continue adding sugar until it will no longer dissolve. Discuss why no more sugar will dissolve.

Students may be able to compare this to a glass of tea or chocolate milk. When no more sugar or chocolate will dissolve, it sinks to the bottom of the glass.

Help students infer that this is very much like wildlife habitat. There are only so many animals that can be carried in a habitat and no amount of "stirring" will help.

Carrying capacity refers to the number of animals that a habitat can support with the available supply of food, water, shelter, and living space.

Some information on solubility may also be helpful for this activity. As you stir sugar into the water, it will dissolve until you have added all the sugar the water will "hold". When it reaches this point, it is saturated. When the water becomes saturated with sugar, it will dissolve no more, so any extra will sink to the bottom.

TITLE: Big Problems Come in Small Packages

CONCEPT: Conservation is the responsibility of every individual.

PURPOSE: Upon completion of this activity, students will:

1. understand the extent to which paper is wasted in the packaging process;

2. understand the relationship of paper waste to resource abuse and solid waste pollution.

MATERIALS:
paper
pencils

PROCEDURE:

Our society has a big appetite for paper. Consider the paper demand within the food industry. Some of this is apparent by observing the way food is packaged at a grocery store or carry-out restaurant. For a simple hamburger dinner we may use up just a few paper items (if we buy the raw materials and prepare our own meal) to a vast array of paperstuffs (if we go to a carry-out type of restaurant).

As a common example, a family outing for hamburgers results in the use of hamburger wrappers; sacks for the wrapped hamburgers; napkins, straws wrapped in paper; salt, pepper, sugar and powdered cream in paper packets; coffee cups; soft drink cups; and cardboard trays on which to carry all of these. And, all the packaging is discarded within 15 minutes after its contents are consumed.

Energy studies show that the equivalent of 12.7 million tons of coal and a sustained yield of 315 square miles of forest (twice the land area of the city of Tulsa) were used to provide packaging materials for hamburgers sold by just one fast-food chain in 1971 (Chicago Sun Times, Monday, October 20, 1972).

For this activity, each student will keep a record of his family's food-packaging paper use for a given period of time, such as a week or a month. Students should list separately items related directly to food packaging (boxes, sacks, etc.) and those items consumed but not essential to food packaging (napkins, advertising, etc.).

When the students have completed their paper use survey, they shall use their findings to answer the following

questions:

1. What items of paper does your family use?

2. How much of each item do you use per week (or in a month)?

3. How many of these paper products could be packaged in materials which could be sterilized and reused (such as glass containers)?

After students have answered these questions, compile a master list of everyone's data on the blackboard. Ask the class to explore the following questions:

1. Which of the items listed are overpackaged (paper used for decoration rather than neccessity)?

2. Where and how does your town dispose of solid wastes (e.g. landfill, incinerate, recycle, etc.)?

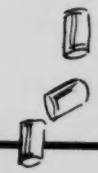
3. Is there anything your class could do to reduce paper waste? Could this be done on a city-wide basis?

TITLE: Aluminum Can Drive

CONCEPT: Conservation is the responsibility of every individual.

PURPOSE: Upon completion of this activity students will:

1. develop an awareness of solid waste pollution and its effects on man and animals;
2. have developed habits of recycling materials and will see that recycling is feasible;
3. have developed habits of working together for a common goal.

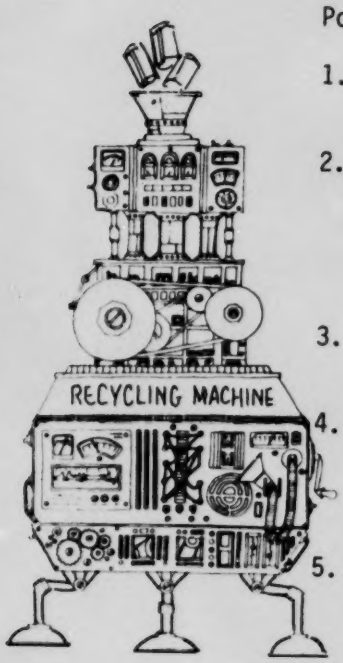


MATERIALS: garbage bags in which to store the cans
a storage area to keep the cans at school

NOTE: The Coors Brewing Company of Golden, Colorado provides information on aluminum recycling free on request.

PROCEDURE: Begin class with a discussion about pollution in general.

Points to cover:



1. Q. What is solid waste?
   A. Wastes of society which are not liquids.
2. Q. What causes solid waste pollution?
   A. Pollution occurs because of the huge amount of solid waste that requires disposal. Much solid waste is "litter" carelessly discarded by individuals.
3. Q. What can be done by industry to reduce pollution?
   A. Utilize recyclable materials.
4. Q. Name some solid waste pollutants that remain visible for years.
   A. Car bodies, tin and aluminum cans, plastic bottles, etc.
5. Q. What can individuals do about pollution?
   A. Buy products which are packaged in recyclable materials, get into the habit of recycling household items.

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6. Q. What is recycling?
   A. Recycling is the process by which natural resources are conserved through converting used products into usable ones again.

Suggest an aluminum can drive for the class and have them name some benefits to be gained. For example:

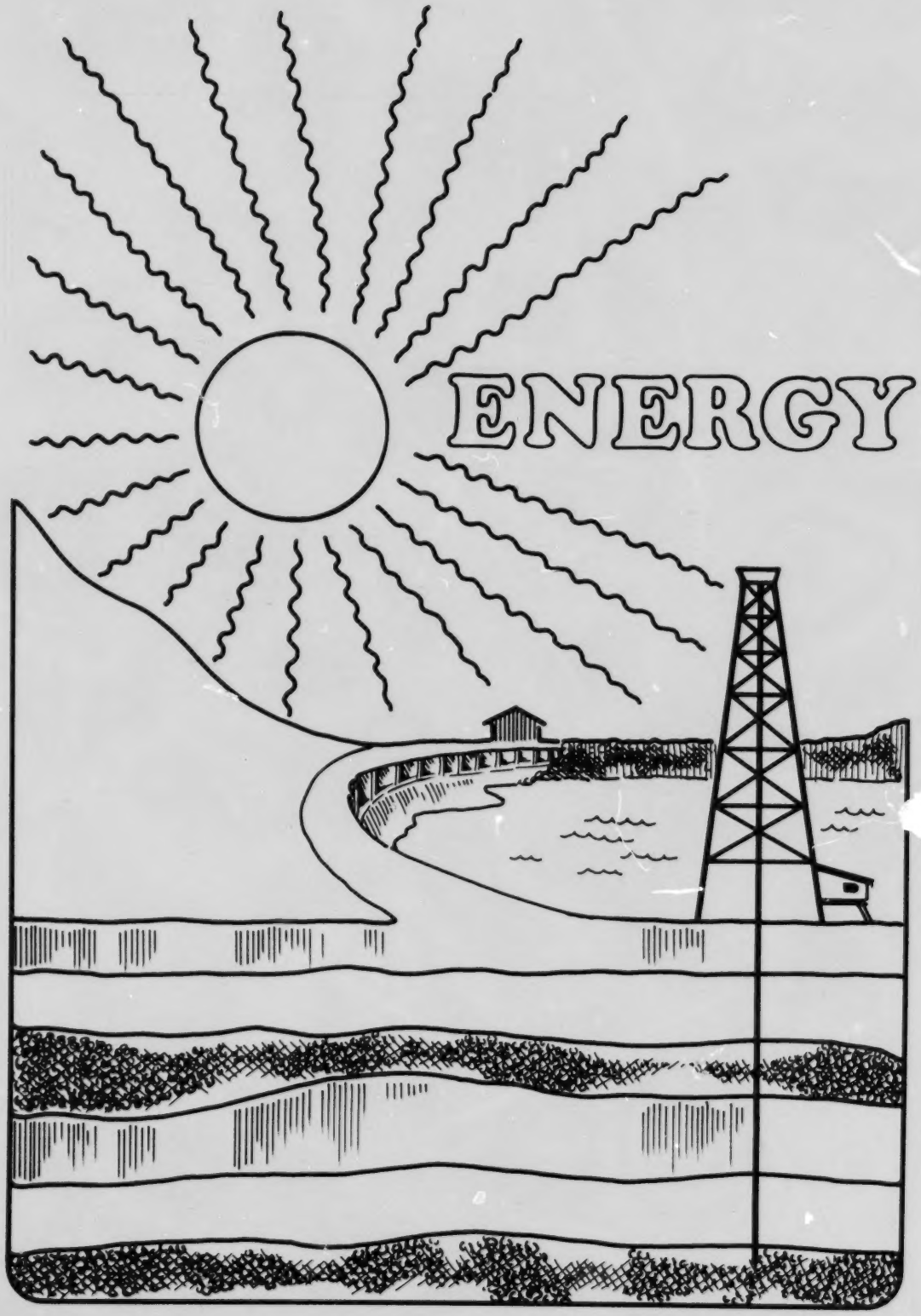
1. cleaner landscape
2. safer areas for recreation
3. conservation of natural resources
4. community involvement with the school
5. money for some class activity or project

All records, communications, and publicity should be handled by the students.

1. Set a goal to be achieved along with a completion date.
2. At school, put up a chart designed like a large thermometer.
3. Have students write letters to local businesses for possible aid in collections.
4. Have students write "news releases" for distribution to media and have one student research the addresses of all local papers, radio and television stations. Have students address all news release envelopes to News Director. The news release should simply state the facts: who, what, when, where, and why.
5. Have students compose a letter to their parents describing the project and the need for their help.
6. Make arrangements for placement of cans. The school parking lot might be a good place.
7. Check on pick-up points and dates by aluminum companies in your area.
8. Make arrangements to have cans at pick-up points on time.
9. At the end of collection, notify parents and businesses, also local media, of outcome of the drive.

10. Keep a record of each student's contribution on a bar graph.

11. Give the class a reward if the goal is reached.


ENERGY

CHAPTER 4

ENERGY

It is difficult to comprehend the enormous amount of energy consumed in the United States, or even in Oklahoma. Even the statement that each person's share of the total energy used in 1977 was estimated to be 349,000,000 British thermal unit (BTU) impresses only because of the number.

Our present life-style keeps many of us from seeing the work being done by the energy resources we use. Thus we are no longer aware of the real value of energy or of the amount being used. Living in an industrialized, energy-intensive society, we are able to start our cars with the turn of a key, and transport ourselves (often alone) from place to place at high speeds in several thousand pounds of metal, rubber, and plastic, with very little thought of how much energy is being used. Only when the engine fails and the car has to be pushed or towed do we become momentarily aware of the amount of energy it takes to move the car.

Of course, the energy problem is not limited to the United States; it is worldwide. Therefore, we must all work together to conserve our energy resources.

In terms of energy resources, the United States is the most spoiled, self-indulgent, and extravagant nation in the world. The United States consumes more energy than West Germany, Japan, Great Britain, and Russia combined. Although the United States has only six percent of the world's

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population, it consumes about 33 percent of the world's energy.

Clearly, this country has a special problem -- first, because it consumes so much energy and, second, because so much of the energy consumed is nonrenewable. Some resources such as iron, coal, and minerals are not renewable and must be carefully conserved, recycled, or new alternatives found. Some of our other resources, such as soil, water, forests, grasslands, and wildlife, are renewable and with careful management can be used without destroying them. Keep in mind that the exhaustion of one resource produces demands on other resources.

Our wasteful use of energy in the United States has placed such a heavy demand on energy resources that there is concern about our future. Will there be adequate resources for future generations? It is time that we think about and apply some conservation methods. Some of us may be convinced, however, that Americans need the amount of energy we are now using to maintain our lifestyle. And, in any event, we may think that the little bit we use really doesn't make that much difference.

From Poland comes a dramatic example of how individual conservation efforts can add up to big energy savings:

Polish television did a very simple experiment a few months ago. It had wide appeal and made a topic for discussion in homes, schools, and in the many places where people discuss matters of importance.

In a Saturday evening entertainment program, they screened the meter (with digital display) of the central power distribution station. The reading was more or less constant for 30 seconds or so. Then the entertainer asked the audience politely to switch off one dispensable light in each home. The effect was immediate and beyond expectations. The read-

ing of the meter dropped considerably within a few seconds.

That experiment with an appropriate commentary made a large audience realize the possibilities in economizing on light and fuel. Experiments of this kind may be very helpful in making people use energy more rationally.

Conservation does not mean to stop using energy. It means, rather, to use energy wisely and efficiently with as little waste as possible. Everyone agrees that careless and wasteful use of any of our resources such as land, water, air, forests, wildlife, minerals, or energy, must be prevented.

When any resource is used, however, the possibility of waste is always present. And where energy is available to us at the turn of a key, the flip of a switch, the push on an accelerator, the setting of a thermostat, the opening of a valve, or in numerous other easy ways, there can be waste -- perhaps because our demand for energy is unthinking, routine. A rational person seldom wittingly wastes the resources necessary for life. Rational persons, however, often unwittingly waste these resources.

How can an individual use so much energy, and perhaps waste so much? Let's look briefly at some of the uses of energy in providing the basic necessities of life -- food, shelter, clothing, and transportation -- in our daily living.

Our food system uses an estimated 12 percent of all the energy consumed in the United States. This use of energy begins with production and continues until the food appears on the table. A considerable part of the total energy used in the food system is spent in farm-related

activities such as operating farm equipment, production of steel for farm machinery, generation of electricity for farm operation, irrigation of crops, and manufacture of fertilizers.

Very little of our food comes to the table directly from the farm. Much of it is processed first. Energy runs the food processing machinery and for the trucks and freight cars to transport the food. Energy is needed to manufacture glass, cardboard, steel, and aluminum for containers. It is estimated that more than a third of the total energy necessary for our food system is used in processing and packaging.

Once the food is processed and ready for home or commercial use, much of it requires refrigeration. Refrigeration makes it feasible to store the food for longer periods, and to prepare foods for "instant" home use. But refrigeration requires energy not only for storage but also for the manufacture of refrigeration equipment. Finally, our food requires energy in its preparation for eating.

By the time our food reaches the table ready to provide the calories needed for our physical energy, it is estimated that nine calories of energy resources have been invested for each calorie available in the food. In effect, wasting 100 calories of food can waste approximately 1,000 calories of energy.

The abundant use of energy in our food system has enabled the United States to achieve a relatively high standard of living. The increase in the use of energy, however, has been great. Since 1940, the amount of energy used in our food system has increased threefold. In other words, it is possible to waste much more energy now by wasting the same amount of food wasted in 1940.

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Our driving habits have caused much of the enormous demand for energy in our transportation system. In recent years, more than 50 percent of the oil consumed in the United States has been for transportation.

One person riding in a car averaging nine miles per gallon (one gallon of gasoline = 125,000 BTU) in suburb-to-city driving, uses approximately 24,000 BTU per mile traveled. This figure is obtained by adding to gasoline use the energy it takes to manufacture and maintain the car. Transportation efficiency can be improved by increasing the number of riders per car from the current 1.4 average. Raising the average to 2.0 persons per car could reduce gasoline consumption by an estimated five billion gallons per year. And, if 40 percent of commuting cars carried one additional passenger, it has been said that 2.5 percent of total oil consumption in the United States could be saved.

For many people, the basic necessity of shelter in the United States today includes not only heating, cooking, lighting, refrigeration, and hot water, but also clothes drying and air conditioning. This energy use accounts for about 13 percent of our total energy consumption. Can we reduce this use of energy? What happens when people make a conscious effort to reduce energy use is graphically demonstrated by data from the natural gas industry. In the fall of 1973 during the oil embargo and in the winter following, people were asked to conserve energy. A 1977 study reveals that consumption of natural gas per customer per degree day (a degree-day is defined as the negative departure of the mean daily temperature from $65^{o}F$) was about 9 to 10 percent less than pre-embargo levels during the winters of 1973, 1974, and 1975, and was about 13

percent less than pre-embargo levels in the extremely colder-than-normal winter of 1976.

The reduction can be even greater when everyone becomes more conscious of the waste of heat energy in the home. For example, people are discovering that proper insulation reduces energy use by as much as 20 percent. Even such seemingly inconsequential acts as turning off unneeded lights, keeping entrance doors closed, using hot water at a lower temperature, using the dishwasher only when it is completely loaded, taking shorter showers, fixing leaking faucets, etc. can make a significant saving.

Our lifestyle uses much energy for space heating and cooling, for transportation, and for our food system. Additionally, it requires large amounts of energy for the many consumer products, both durable and nondurable, we demand, ranging from electronic equipment and house furnishings to cosmetics and clothing. Appliance manufacturers are now building more efficient appliances, using the argument that the savings on energy will help pay the cost of the new appliance.

About two-thirds of our textile fibers are synthetic. They use petrochemicals which are derived from petroleum feedstocks and which also require energy to process. Taking proper care of clothing, therefore, is but one more way to conserve energy resources.

We live in the kind of society where much of our work is done for us by energy-using machines. Should we not be more thoughtful about the efficient use of energy where and when we can make the decision? Look at the following suggestions on how you can save energy and money at home:

Heating Your Home:

1. Set the thermostat no higher than 68 degrees during the day and leave it there.

2. At bedtime, turn down the thermostat to 60 degrees. Also, turn it down if you plan to be away from home to avoid wasting heat in an empty house.

3. Keep bedroom windows closed. (Or close the bedroom door if you open the windows at night.)

4. Storm windows and doors help a lot. (An inexpensive substitute is to staple clear plastic across windows and screen doors.) Weatherstrip or caulk around windows and doors that allow drafts in and heat out. But don't seal up windows and doors near the gas furnace and water heater. These appliances need an air supply for proper operation.

5. Insulate. Uninsulated or underinsulated walls and attics are a major cause of heat loss. To be sure your home is efficiently insulated, see your insulation supplier.

6. Replace your furnace filters at least twice each heating season.

7. Avoid blocking air vents or radiators with furniture or draperies.

8. Keep draperies drawn over large window areas -- especially on cold nights. On sunny days, let the sun shine in.

9. Be sure the damper is closed when your fireplace is not in use.

Drying Your Laundry:

10. Dry a full load each time but avoid overloading.

11. Keep the lint filter clean.

12. Use the automatic drying controls.

Water Heating:

13. Repair leaking faucets promptly. One drop a second can waste from 70 to 200 gallons of water a month.

14. Use hot water only as needed, i.e., shaving or washing dishes. Continuously running water is wasteful.

15. Check the temperature of your hot water. Is it hotter than you really need? Also, turn down the water heater temperature control when you plan to be away for an extended period of time.

16. Operate washing machines with low water temperatures whenever possible. Don't wash clothes until you have a full load.

17. When practical, use the "short wash" cycle for dishwashers and wash only a full load.

Cooking:

18. Don't preheat the oven more than 10 minutes. Preheat only when necessary for baking.

19. Check gas flame for a clear blue color. A yellowish flame indicates adjustments may be needed.

20. Keep lids on pots and pans while cooking.

21. Avoid rapid boiling unless recipe specifically calls for it.

22. Don't turn gas flame higher than needed -- flame should never curl around the sides of pans.

Schools are large energy users, and today's energy situation has a direct impact upon everyone connected with schools -- including students. Your school's student body can contribute more toward conservation than anyone else. Please read the following energy conservation tips, and ask your principal to establish an energy conservation committee, made up of administrators, teachers, and students, to work together to save energy money.

Students:

Students can survey the school for energy usage.

In Classrooms and Hallways:

1. Find out what kinds of energy are used by the school and for what purposes.

2. Find out what the methods are for measuring energy usage.

3. List the school's energy decision-makers.

4. Survey the kinds of energy being used in the classroom (heat, light, food, electrical).

5. Figure out ways to measure how much energy is being used (thermo-

meters and light meters).

6. Check for lights burning near sunny windows; unnecessary lights burning in hallways and classrooms; other energy misuses.

In the Boiler Room:

7. Have students learn how to read gas and electric meters.

8. Determine the type of furnaces and how much energy they use each month.

9. Find out how water is heated.

10. Trace the ductwork to the classrooms.

In the Kitchen:

11. What is energy used for and what kind is used?

12. Students might want to discuss "energy-saving" equipment. How many people work in the kitchen?

13. What are some ways to conserve energy?

In the School Garage:

14. Find out how many buses the school system operates and how many miles a day each bus travels.

15. How many miles per gallon of gasoline do the buses get?

16. See if buses are kept in a heated garage.

17. Find out how old the buses are and if they are on a regular maintenance schedule.

18. Are bus routes set up to get the most of each energy dollar?

(In addition to these school-related activities, the science and math classes can be involved in a variety of ways. By recording and tracking consumption data, a number of interesting problem-solving activities can be developed for or by the students.)

Administration:

1. Develop an energy conservation plan.

2. Form an energy committee to look at energy consumption and possible

ways to reduce it.

3. Assign an energy monitor for each building.
4. Maintain a history for energy consumption and costs.
5. Establish a preventive maintenance program for the school district.
6. Update the training of the maintenance and custodial personnel.
7. Develop an awareness among employees of the need to conserve energy.
8. Report results to the School Board.

Heating and Cooling:

1. Establish a standard temperature setting for occupied and unoccupied times.
2. Turn down thermostats to temperature established by School Board.
3. Calibrate the controls and thermostats.
4. Insure that time clocks are properly set.
5. Establish a standard set-back temperature during unoccupied periods.
6. Adjust time clock to match weather conditions.
7. On HVAC (heating, ventilating, air conditioning) system, only allow the first heat zone to turn on automatically.
8. Do not begin heating the building too soon in the heating season and reduce operating time as it warms up.
9. Shut down heating units completely when building is not occupied and there is no danger of freezing.
10. Turn down the night set-back before students leave depending on outside temperatures.
11. Turn down heat in unused areas of the building, especially at night, weekends, or when not in use.
12. Make sure the following are turned off at night, weekends, and unoccupancy times:
    a. Cooling or condenser fans
    b. Chilled water and condenser pumps
    c. Supply and exhaust fans

d. Cooling towers, fans, and pumps

e. Boilers which supply absorption units

13. Reduce rate of infiltration.

14. Do not block radiators, registers, or air flow to univents and window line heating units.

15. Limit the number of entrances students and teachers use for normal arrival and departure.

16. Keep doors closed in hallways.

17. Shorten time on door closers.

18. Reduce relative humidity levels.

19. If possible, consider waste heat recovery.

20. Make full use of window shades, draperies, and blinds.

21. Close drapes at night during cold weather.

22. Protect occupants from cold exterior surfaces; for example, pull drapes, close venetian blinds.

23. Plant windbreaks.

24. Use the heat from sun whenever possible.

25. Turn off cooling systems during unoccupied hours.

26. Turn off all unnecessary heat producing equipment in the cooling season.

27. Establish a cooling level of no less than $78^{o}F$.

Boiler Operations:

1. Check for inefficient boilers.

2. If there is more than one boiler, operate it to the maximum before turning on the second boiler.

3. Keep flues clean in the boilers.

4. Insulate bare steam lines to reduce heat loss.

5. Maintain proper water level in boilers.

6. Check for steam leaks in lines.

7. If you heat by steam, make sure the steam valves do not leak and that the steam traps function properly.

8. Clean tubes on all boilers at regular intervals to obtain maximum operating efficiency.

9. Schedule boiler blowdown on a fixed timetable.

10. Minimize boiler blowdown with better feedwater treatment.

11. Smaller and more frequent blowdown quantities are preferable to larger quantities and less frequent blowdown.

12. Insure that boiler water is properly treated so that pipes are not coated with calcium or other impurities which reduce the efficiency of the system.

13. Remove built-up scale in boilers and hot water heaters.

14. Use minimum steam operating pressure.

15. Turn off gas pilots for furnaces, boilers, and space heaters during the nonheating months.

16. Use warm exhaust air from adjacent areas, or from the ceiling of the boiler rooms, to preheat combustion air.

Ventilation:

1. Shut down ventilation systems during unoccupied hours.

2. Reduce ventilation rates during occupied periods.

3. Close the cover baffles, vents on rooftop, and window air conditioners during the heating season.

4. Insure that outside air dampers fit properly and do not leak cold air when closed.

5. Close off univent intakes in cold weather.

6. Establish a policy of zero ventilation during unoccupied periods.

7. Turn off exhaust fans in toilets, kitchens, and labs when not in use.

8. Clean all filters often.

9. Insure all air filters are cleaned or replaced when they become loaded with dust.

Retrofitting:

1. Additional insulation.
2. Use caulking and weather stripping where needed.
3. Add storm windows.
4. Consider replacing old poorly fitting windows with other than glass or reducing the amount of glass area.
5. Consider making vestibules at the heavily used entrances.
6. Make sure that doors fit tightly or are weather stripped.
7. Add drop ceiling where practical.

Hot Water Heaters:

1. Reduce temperature for hot water heaters except where needed for dishwashers.
2. Reduce hot water use in showers by using flow restrictors.
3. Insulate hot water storage tanks and pipes carrying hot water.
4. Turn off domestic hot water circulating pumps when not required.
5. Turn off hot water heaters during vacation periods.
6. Make sure the hot water booster heaters are off during the summer vacation.
7. Install independent hot water heaters to allow complete shutdown of boilers in summer.
8. Check plumbing for leaks.
9. Flush and clean hot water heaters every year.

Lighting:

1. Use 34-35 watt fluorescent lamps in place of 40-watt lamps.
2. Reduce lighting in hallways and corridors to the minimum limits.
3. Replace incandescent with fluorescent lighting or mercury lights.
4. Keep lighting fixtures and lamps clean.
5. Reduce lighting levels in supply areas, storage areas, hallways and corridors (only 20 footcandles required).

6. When you leave a room, turn off the lights -- 7-10 minutes for fluorescent, immediately for incandescent.

7. Turn off lights in unused areas.

8. Install timers on light switches in little-used areas.

9. Use photoelectric cell to control outside lights.

10. Decorate with colors that reflect light.

Kitchen Procedures:

1. Preheat ovens for a minimum amount of time; do not allow ovens to remain on warm for long periods. Reduce heat as soon as possible.

2. Cook by time and temperature for best results. Use minute timers for precise cooking operations.

3. Don't open oven doors more than necessary to check foods being prepared.

4. Keep pots and pans covered while cooking whenever possible.

5. Match pan size to burner unit size.

6. Use small amounts of water whenever possible; the food will heat faster.

7. Insure that refrigeration heat exchange surfaces are cleaned on a regular basis.

8. Exhaust only enough air from the kitchen areas to reduce food smells -- slow down the fans, for example.

9. Eliminate use of electric can openers.

Activities:

1. Add energy conservation to the curriculum.

2. Consider scheduling all nighttime activities in one building or as few buildings and wings as possible.

3. Schedule adult education programs to meet in rooms which receive full use during the day to utilize the existing room heat.

4. Conduct basketball and volleyball outside as much as possible and during daylight hours.

5. Eliminate refrigerators in science labs or classrooms where not absolutely essential.

6. Use kilns only with a full load.

7. Curtail use of resistance-type electric equipment, such as space heaters, coffee pots, and hot plates.

NOTE TO TEACHER: Obtain permission from administrators for this activity. It is suggested that following class discussion of these energy saving tips, students volunteer (or are selected) to interview school personnel responsible for each area listed. Students should stress the need for conservation of energy and request cooperation of all school personnel in effecting overall reduction of energy consumption. Students will then return to class and report on information received. Periodic follow-ups can be made and records kept to determine effectiveness of students concern in this matter.

The energy problem is not new. In 1744, Benjamin Franklin observed:

"...since fuel is becoming so expensive, and (as the country is more cleared and settled) will of course grow scarcer and dearer; and new proposals for saving the wood, and lessening the charge and augmenting the benefit of fire, by some particular method of making and managing it, may at least be thought worthy of consideration."

Over 92 percent of the United States energy consumption in 1976 was accounted for by three nonrenewable fossil fuels. This country may have only a few decades of petroleum and natural gas left and, although there may be enough coal to last several hundred years, coal (as currently mined and burned) pollutes at levels that many Americans are not willing to tolerate. Breeder reactors, if used in the future, will produce plutonium (plu-toe'-ne-ahm), an extremely toxic element. Fusion power may not arrive for at least another 25 years -- perhaps longer -- and therefore cannot be considered a solution to our current energy problem. Other nonrenewable energy sources (solar, wind, geothermal) may be used to a greater extent in the near future, but not sufficient quantities to

be considered solutions, either.

We have to begin developing new attitudes about energy, about coordinating demand with supply, and adjusting our behavior accordingly. Like it or not, no matter what we do or don't do about our energy problem, some changes in patterns of energy consumption must be anticipated.

We have to think of energy problems within three time frames: the short-term (5-10 years), medium-term (10-20 years), and the long-term (more than 20 years). Because some solutions will take 20 or more years to effect, we must start thinking about implementing them now. If we set about the task with seriousness and purpose, calmly and openly weighing the energy choices before us, we could build a foundation for resolving our energy problem.

Oil and natural gas are complex molecules of hydrogen and carbon formed from the decay of microscopic organisms that died and were buried in sediments of ancient seas that once covered Oklahoma. Deep burial of these organisms created sufficient heat and pressure on their remains to transform them into oil and gas that could be squeezed out into more porous rock. They do not exist in large open cavities or pools as is sometimes believed due to use of the term "oil pool".

Oklahoma's significance to the nation's energy supply depends on the state's total energy output from fossil fuels and it's internal use patterns. The Federal Bureau of Mines reports that 64 percent of energy consumed in the state was derived from natural gas and 32 percent from petroleum products. Thirty-five percent of the natural gas produced was consumed in the state, and more than 44 percent of the consumed gas was used to generate electric power. In fact, 89 percent of all electric

power generated in Oklahoma was by means of natural gas. Massive dependence on natural gas was broken in 1977 by the construction of the first of a series of coal-burning, power-generating units. Necessary replacement of obsolete and worn out boilers in the next 20 years is expected to allow many plants to switch from natural gas to coal and nuclear generation of electric power, and thereby free a large share of natural gas for other uses in statewide and nationwide markets.

Oklahoma's mineral wealth is tremendous and is evenly distributed throughout the state. Numerous and varied mineral industries are active in each of the 77 counties, and oil and gas have been produced in 73 counties. Oklahoma is well known as an energy mineral state. Oil, gas, and coal account for a major portion of these minerals. Untapped resources of uranium also constitute an important source of energy minerals.

Low sulfur coal is in short supply and is inadequate for future needs. To meet our energy needs in the immediate future, we need to rely on coal with a fairly high sulfur content. Most experts agree there is enough of it in the earth to last another 500 years.

Can sulfur be removed from coal before it is used? ... or ... Can a process change in burning reduce the effects of sulfur content?

The answer to both questions is yes... through gasification and liquification. However, improvement of these processes on a large scale, in order to meet the requirements of sulfur control laws, is still under way. None are low enough in cost.

At present, a great deal of surface mining removes coal anywhere from a few feet below the ground to in excess of 100 feet deep. Often a huge volume of overlying rocks and soil has to be removed to uncover a

coal bed of one to two feet in thickness. In doing so, the topsoil is removed carefully and saved to spread over the subsoil later during the reclamation. A casual look at a surface mining operation may give the impression that the whole process is awkward and haphazard. The soil, air, and water resources are being polluted. Trees and vegetation from the prime farmland are uprooted. Fish and wildlife resources, and in some cases, even the historical and archeological features are being disturbed forever. But for an eye trained in the science of mining and reclamation, these are only temporary and necessary disturbances because there is no other way to recover the mineral resources.

In the recent past, several government regulations and laws have been passed to protect the environment and to maximize the production of the resource. These laws were needed because so many mining companies were interested only in the production of the mineral and not in reclamation of the land. As a result of that attitude, lands were left behind unreclaimed, causing air and water pollution, erosion from barren slopes, and smoke from burning spoil piles. This was passed on the the next generation because reclamation of mined land was not required. In Oklahoma we have 36,000 acres of such lands, called "orphan lands".

In 1977, President Carter signed into law legislation which created a federal agency to enforce standards designed to protect the environment and improve the visual quality of the orphan lands. Modern mining and reclamation techniques are now considerably advanced and usually result in better quality of land and recreational facilities than existed before. Trees and shrubs are planted along the stream-bed to enhance cover and feeding grounds for the wildlife. The last open cut can be left as a

source of water for fisheries, stocks, and birds, as well as recreation activities such as swimming. The reclaimed land is blended with the surrounding topography and ecosystem. Any historical or archeological remains, which should be preserved, are protected by establishing a buffer zone or by declaring the area unsuitable for mining.

Where underground mining is conducted, special efforts are made to control health hazards such as noise, dust, and emission of poisonous gases. Safety to the miners is of paramount importance, and subsidence is prevented by applying careful engineering techniques.

In general, things have changed and government regulations require that the public be involved in the decision-making process when it is suspected that the mining may cause danger to the public safety and damage to the environment.

Technology and proper management can restore the land to its former state; education should control future occurrences of destruction. How we use Oklahoma's limited land resources will determine the quality of our environment. We can learn from our own past mistakes, and the mistakes of the developed states of the central and eastern United States.

One must remember, forever, that our soil, water, wildlife, range and forest resources are limited resources that can be lost without conservation practices. How they are to be used is a choice you must make. A good energy conservation motto is: "If it is to be, it is up to me."

Strip Mine Area

Figure 17

BEST COPY AVAILABLE

Undisturbed Land

Reclaimed Land

Figure 18

Original Undisturbed Land. Comparison of original area and reclaimed area is favorable. Every effort is made to restore area to its original appearance.

Reclaimed area. Land is frequently in better condition following reclamation due to loosening of soil, addition of nutrients, etc.

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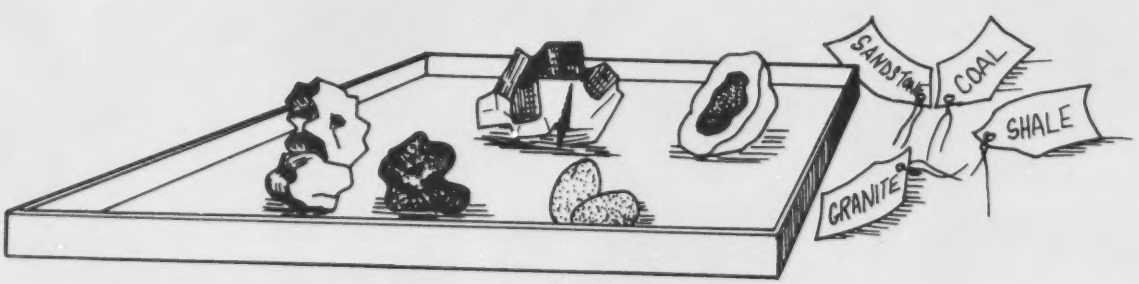
TITLE:	Fossil Fuel Material Identification
CONCEPT:	Fossil fuels are obtained from several kinds of rocks and are graded by the amount of energy and pollution they produce.
PURPOSE:	To be able to recognize fossil fuel-bearing rocks.

MATERIALS: specimens of:

oil
shale
bituminous coal
anthracite coal
asphaltic sandstone
lignite coal
peat
trays (see appendix - a design made from recycled poster board , page 234)

PROCEDURE: While passing each specimen to be examined by the students, tell of its properties, where mined in Oklahoma, its value as energy, etc., (the flame test can be demonstrated to show combustion). Also, give each student a bag of materials to identify by list or to properly place in a tray.



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TITLE: Oil Field Collage

CONCEPT: Oil is hard to find and even harder to obtain. Oil is a finite (fine'-ite), non-renewable and highly sought after resource. Basic facts about the natural uses and sources of energy are critical to all energy decisions. Everyone must make energy related choices.

PURPOSE: Oil -- where is it? Make a collage and find out!

BACKGROUND INFORMATION: Oil! For more than 100 years this cry has excited the imagination to such an extent that many have left home and family to go in search of it. Earliest oil seekers had to rely on such obvious signs as oil seeps to help them decide where to drill. As experience increased they gained new insight into geologic conditions that control the occurrence of oil. Oil occurred only in sedimentary rock: shale and limestone, where fossilized plants and animals permiated the stone usually in a simple upfold or anticline. The best potential reservoir rock is the porous sandstone capped by a thick layer of impervious shale. Oil normally tends to migrate upward because it is lighter than the water that saturates the rock beneath the surface of the ground or ocean. Oil trapped by the over-riding shale awaits discovery.

MATERIALS:
collecting bags
glue
scissors
black magic markers (for oil)
lightweight cardboard, 12" x 8", or heavy construction paper (student quantities)
dry spaghetti (for drill pipe)
toothpicks (for derrick)

PROCEDURE:

1. Students or teacher may collect samples of sand, dirt, gravel-limestone (chat), if available, sandstone (crushed by hammer), shale, if available (crushed into small chips), and small fossil fragments (not necessary, but will create an added interest). NOTE: Collect these items in advance.

2. Make the collage (see following activity for guide).

   Step One. Draw a mountainous horizon line near the top of the paper.

Step Two. Create a toothpick derrick and drill pipe.

Step Three. Draw on convex lines for the sedimentary rock, soil, and sand samples.

Step Four. Spread glue on one section of the collage at a time, sprinkling with samples of of materials.

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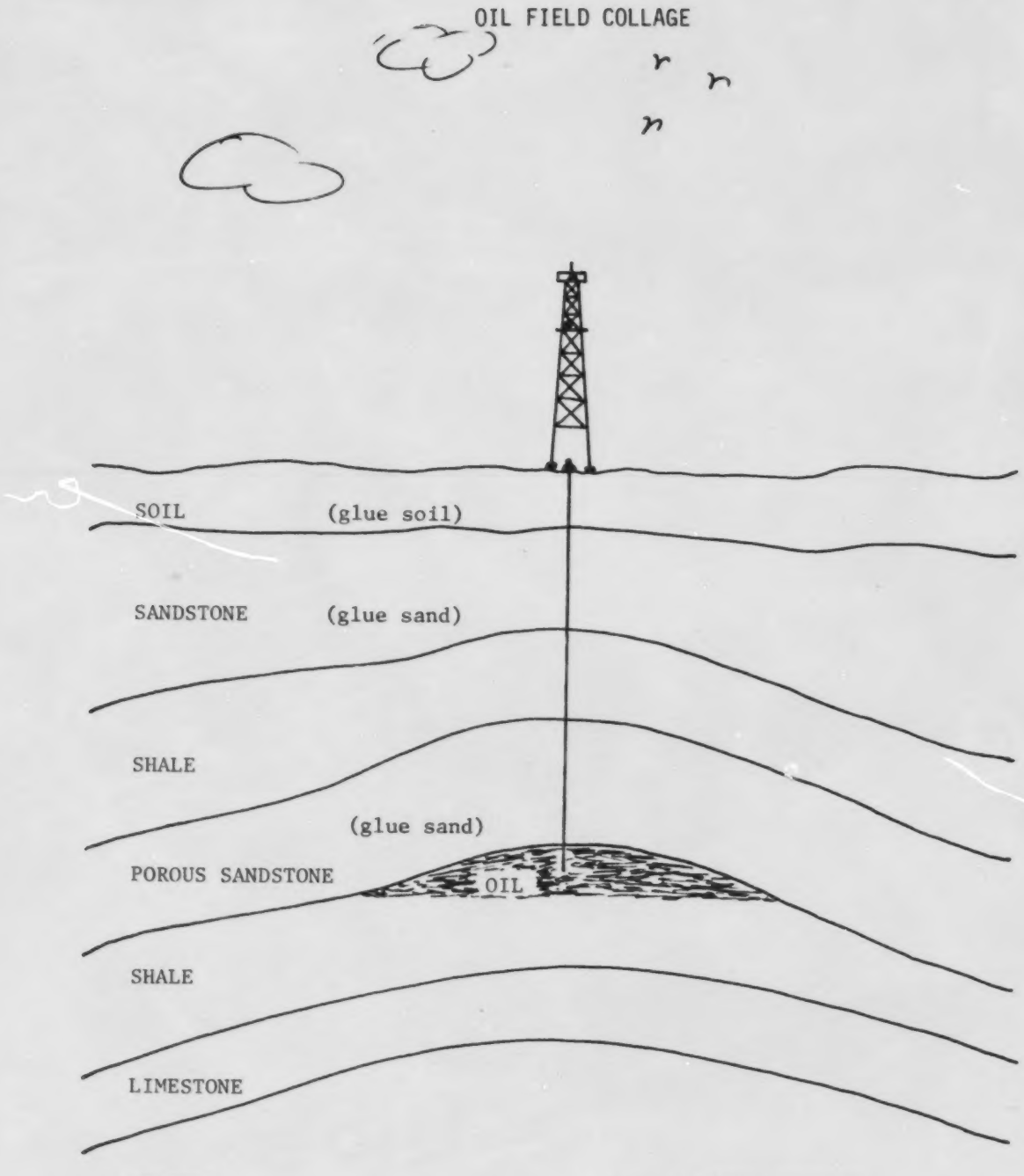

SAMPLE SEISMIC SECTION

To be used for the collage of an oil yielding micromonocline.

Figure 19

TITLE:	Oil in Sandstone
CONCEPT:	Underground oil is held in the small holes of sedimentary rock.
PURPOSE:	To show how oil is within the rock itself.

BACKGROUND INFORMATION: Any rock has space in it. Some rocks, like sandstone, are quite porous. As oil and natural gas form from living matter and the sand is compacted into sandstone, the oil is held in the rock. It is not deep in the ground as a puddle or pool.

MATERIALS:
jar
small rocks
sand
water
sugar

PROCEDURE:

1. Fill a jar with small rocks.
2. Add sand to fill jar.
3. Slowly add water to fill jar (acting as oil).
4. Add sugar cautiously (acting as natural gas).

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TITLE:	You, Us, and Electricity
CONCEPT:	Conservation is the responsibility of every individual.
PURPOSE:	Upon completion of this activity, students will be able to: 1. state how the use of electricity relates to environmental degradation; 2. determine how many of their daily habits and activities could be changed to cut their demand for electricity and consumption of natural resources.

MATERIALS: copies of table for all students
paper
pencils

PROCEDURE: The general purpose of this activity is to teach students that they hold the key to solving environmental problems. To do this, lead students in a discussion assessing their own use of a natural resource, electricity. Use material provided in the background as points to discuss. It should become apparent to students that they each have an impact on the environment. This awareness should be used to encourage students to examine what they can do to minimize their exploitation of natural resources.

After the initial discussion, ask students to make as complete a list as possible of electrical appliances in common use in their homes. You might provide some newspaper or magazine advertisements for ideas.

Then have the students list their family's activities involving the use of appliances from the time they get up until they go to bed. They should do this as part of a weekend assignment during which each can observe all his family members for one day.

After students have observed their families, refer to the electrical consumption table and tell them to calculate the amount of electricity their families use annually. Lighting and certain other uses of electricity will not be included in the table. Then add the total electricity used by all families studied.

Discuss the following points:

1. Electricity is produced from three different energy

sources. These are fossil fuels (oil, coal, and natural gas), nuclear power, and hydroelectric power. In the first two types, fuel is burned to generate the electricity. Hydroelectric power involves the use of falling water to power the generators.

2. The use of fossil fuels creates serious pollution problems. Fossil fuels are the third largest source of air pollution in the U.S. The burning of fossil fuels dumps more than 45 million tons of pollutants into the ecosystem each year.

3. Air pollution is not the only hazard. Both fossil fuels and nuclear powered electricity plants require vast amounts of water to cool the generators. Together, these types of plants account for more than four-fifths of all uses of cooling water in the nation, making thermal pollution (the heating of rivers and lakes) one of the major types of pollution originating from electrical production. Depending on a variety of things, dumping hot water into rivers and lakes can kill fish and plant life in the waters.

4. Development of all three energy sources causes the loss of wildlife habitat. Strip mining for coal, pipelining fuel across the Arctic tundra, and construction of hydroelectric plants all represent potential loss of wildlife habitat.

After this discussion, the students should be able to grasp the relationship between a television set, electric can opener, and the water pollution and habitat loss threatening our wildlife. Emphasize to the students that the use of such appliances requires large amounts of electricity, with a corresponding cost to everyone in environmental degradation.

Have students discuss their families' use of electrical appliances as a class. Make a list of some of the more commonly used appliances on the blackboard and then ask students to evaluate whether these appliances are necessities or luxuries. Then ask the students to go through their individual lists and, taking each item, decide which device they would give up first, which second, and so on. Discuss ways to reduce household use of electricity. Try to illustrate through analogy, other ways which the combined cost for all families could be spent in our society.

A CHECKLIST OF APPLIANCES

Most people don't realize how many appliances they have. To help you make your own record of the appliances in your home accurate, here is a list of some common and not so common appliances.

KITCHEN

refrigerator
freezer
dishwasher
electric range
electric mixer
toaster
coffee maker
waffle iron
electric oven
microwave oven
blender
crock-pot
hot-dog cooker
hamburger maker
deep-fat fryer
electric knife
electric can opener
electric clock
trash compactor
garbage disposal
egg cooker
electric frying pan
electric yogurt maker
electric ice cream maker
popcorn maker
food processor
electric crepes maker
electric coal starter
rotisserie
toaster oven
oven vent fan

LIVING AREA

television
phonograph or stereo
radio
computer games
toys
air conditioner
fan
electric bug-killer
ion generator
burglar alarm
smoke detector

BEDROOM

electric heating pad
electric blanket
sun lamp
electric bed

BATHROOM

electric shaver
electric toothbrush
hair dryer/hair blower
hair curler
tooth irrigator
manicure machine
electric facial machine
electric shave-cream heater
portable electric heaters

HOBBY

sewing machine
electric drill
electric saw
slide projector
movie projector
tape recorder
calculator
CB radio
electric exercise machine

OUTDOOR

electric barbecue
swimming pool heater
sauna
garage-door opener

UTILITY ROOM, BASEMENT

vacuum cleaner
electric broom
washing machine
dryer
iron
electric water heater
humidifier
oil burner
fans
door bell
electric hedge clipper
heat pump
central air conditioner

ANNUAL ENERGY REQUIREMENTS OF ELECTRIC
HOUSEHOLD APPLIANCES

APPLIANCE	Average Wattage	Annual kwhr Consumption	Annual Cost*
Air cleaner	50	216	$ 8.64
Air conditioner (room)	997	1,032**	41.28
Bed covering	177	147	5.88
Blender	386	15	.60
Broiler	1,436	100	4.00
Carving knife	92	8	.32
Clock	2	17	.68
Clothes dryer	4,856	993	39.72
Coffee maker	894	106	4.24
Deep fryer	1,448	83	3.32
Dehumidifier	257	377	15.08
Dishwasher	1,201	363***	14.52
Egg cooker	516	14	.56
Fan (attic)	370	291	11.64
Fan (circulating)	88	43	1.92
Fan (window)	200	170	6.80
Floor polisher	305	15	.60
Freezer (15 cu. ft.)	341	1,195	47.80
Freezer, frostless (15 cu. ft.)	440	1,761	70.44
Frying pan	1,196	186	7.44
Germicidal lamp	20	141	5.64
Hair dryer	381	14	.56
Heater (portable)	1,322	176	7.04
Heat lamp (infrared)	250	13	.52
Heating pad	65	10	.40
Hot plate	1,257	90	3.60
Humidifier	177	163	6.52
Iron (hand)	1,008	144	5.75
Mixer	127	13	.52
Oven, microwave	1,450	190	7.60
Radio	71	86	3.42
Radio/record player	109	109	4.36
Range, with oven	12,200	1,175	47.00
Range, with self-cleaning	12,200	1,205	48.20
Refrigerator/Freezer (14 cu. ft.)	326	1,137	45.48
Refrigerator/Freezer, frostless, (14 cu. ft.)	615	1,829	73.16
Roaster	1,333	205	8.20

*Based on a projection of 4¢ per kilowatt hour.

**Based upon 1,000 hours of operation per year; this figure will vary widely depending on area and specific size of unit.

***Does not include kilowatt hours for heating water.

ANNUAL ENERGY REQUIREMENTS OF ELECTRIC HOUSEHOLD APPLIANCES
(Continued)

APPLIANCE	Average Wattage	Annual kwhr Consumption	Annual Cost*
Sandwich grill	1,161	33	$ 1.32
Sewing machine	75	11	.44
Shaver	14	1.8	.07
Sun lamp	279	16	.64
Television (black and white), tube type	160	350	14.00
Television (black and white), solid state	55	120	4.80
Television (color), tube type	300	660	26.40
Television (color), partial solid state	200	440	17.60
Toaster	1,146	39	1.56
Toothbrush	7	0.5	.02
Trash compactor	400	50	2.00
Vacuum cleaner	630	46	1.84
Vibrator	40	2	.08
Waffle iron	1,116	22	.88
Washing machine (automatic)	512	103***	4.12
Washing machine (manual)	286	76	3.04
Waste disposer	445	30	1.20
Water heater (standard)	2,475	4,219	168.76
Water heater (quick recovery)	4,474	4,811	192.44

*Based on a projection of 4¢ per kilowatt hour.

***Does not include kilowatt hours for heating water.

A HOME ENERGY GUIDE TO EFFICIENT ELECTRICAL SPENDING

Electric Product	Est KWH Used Monthly*	Est. Monthly Operating Cost
Air Conditioner (central) per ton - set at 72°	597	$25.95
Air Conditioner (central) per ton - set at 78°	483	$21.01
Heat Pump - per ton of cooling set at 78°	386	$16.81
Air Conditioner (room) per 1000 watts-per hour	300	$13.05
Washing Machine, including hot water	200	$8.70
Freezer (frostless, 25 cu. ft.)	160	$6.96
Refrigerator/Freezer (frostless, 17 cu. ft.)	155	$6.75
Clothes Dryer	150	$6.52
Dishwasher, including hot water and drying	129	$5.61
Dishwasher, including hot water, no drying	114	$4.96
Freezer (15 cu. ft.)	99	$4.30
Refrigerator (frostless 12 cu. ft.)	90	$3.91
Range with Oven	85	$3.70
Refrigerator/Freezer (17 cu. ft.)	85	$3.70
Range with Self-Cleaning Oven	60	$2.61
Television (color)	55	$2.39
Refrigerator (12 cu. ft.)	54	$2.35
Water Heating for one 6-inch bath, per person, per day	47	$1.04
Water Heating for 5-minute shower, per person per day	45	$1.96
Light Bulb (100 watts)	34	$1.48
Fan (attic)	30	$1.30
Television (black & white)	29	$1.26
Electric Blanket	24	$1.04
Fan (window)	20	$ .87
Microwave Oven	16	$ .70
Radio/Record Player (3 hours/day)	10	$ .43
Washing Machine - no hot water	9	$ .39
Iron (hand)	9	$ .39
Coffee Maker	9	$ .39
Frying Pan	8	$ .35
Radio (3 hours/day)	7	$ .30
Vacuum Cleaner	4	$ .14
Toaster	3	$ .13

*NOTE: Energy consumption is measured in kilowatt hours (KWH) - the units of energy which flow through your electric meter. These estimated monthly costs are computed at the rate typical OG&E residential customers pay, approximately 4.35 cents per KWH as of 3/31/80.

TITLE:	Thermal Energy Storage
CONCEPT:	A given amount of energy will raise the temperature of land more than water. Similarly, land loses heat energy faster than water does. This causes the air above land to heat and cool faster than air over water. This influences the movement pattern of both heat and air.
PURPOSE:	To demonstrate the unequal heating of land and water.

MATERIALS:

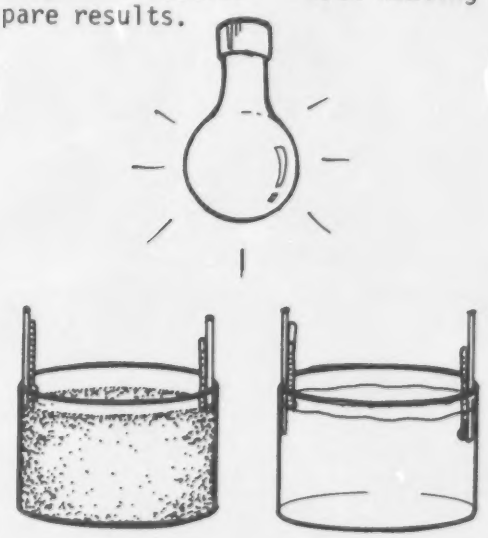
two containers with at least 500 ml capacity
four thermometers
soil, water, graph paper
lamp, 200 watt
ring stand and clamp
two soda straws (to hold thermometers)
masking tape

PROCEDURE:

1. Put soil in one container and water in the other. Tape thermometers to a straw so that two bulbs are just 1 cm above each surface and the other two are 1 cm under each surface. The heat source should be 30 to 40 cm above the surface of the water and soil so that the two surfaces receive equal heat.

2. Turn heat on for 10 minutes, then turn off for 10 minutes. Record the temperature at two-minute intervals.

3. Graph the results -- both heating and cooling. Compare results.



TITLE: Paper Capers

PURPOSE: Upon completion of this activity students will:

1. become aware of how much paper they use in the course of their school assignments;
2. be able to calculate the average amount of paper each student uses each week;
3. learn about some of the things they can do to reduce paper consumption;
4. learn about how excessive use of one resource can result in excessive use of other resources.

BACKGROUND INFORMATION: A three-foot-tall stack of newspapers, folded to half-page size as they are when we buy them, weighs about 120 pounds and represents the wood pulp of one tree. A ton of newsprint uses 17 trees and, if the trees are pulped under the sulphite process, 275 pounds of sulphur, 350 pounds of limestone, 60,000 gallons of water, 9,000 pounds of steam and 225 kilowatt hours of electricity are expended.

Also to be averaged into the environmental impact of our use of paper are the pollution and energy loss incurred in shipping paper from production site to use site and in disposing of used paper.

MATERIALS:
pencil
paper
weight scales

PROCEDURE: Have the students weigh all paper in their desks, including books, notebooks, writing paper, and drawing paper. A postal scale or even a bathroom scale can be used for this.

Keep a master list of each student's total, then ask each of the students to add the numbers to make a grand total for the class. Another way to determine the grand total is by summing up one-by-one, i.e., start with your desk, then add on the total of the first student, then the total of the next student, and so on until all the paper has been weighed.

Once the grand total is reached, have each student:

1. determine the average weight of paper per student;

2. estimate the total weight of paper used by all students in the school. Do this by using the average weight of paper per student found in the first problem.

3. determine the percentage of the class total each student's paper represents;

4. calculate an estimated total weight of paper for each of the other classrooms, using the average weight of paper per student from the first problem.

Now that the students are aware of the magnitude of their use of paper, tell them about the other materials used in the production of paper at the paper mill (see background information). Then, remind them that before the paper was made at the mill, the raw materials for the paper had to be brought in. This brings up questions about the whole logging process, including transportation of felled trees, location of actual logging sites, cleanness of the logging technique, quality of the regenerated forest, and other environmental factors.

Now point out that getting the paper from the mill to a local distribution center and from the distribution center to the school also involved the use of energy and traffic space. Have the class investigate the effects of paper production and transportation on the environment.

Tell the students they have now finished half of the story that tells of the odyssey of paper, for, once in the classroom, the paper must be used and disposed of.

Investigate the disposal of used paper. Trace the route the paper takes from the classroom waste basket back into the outer environment. Consider how waste paper is collected from each classroom, how it is transported to the outside, whether or not the school incinerates the paper and, if it does, what incineration represents in energy costs. Also discuss the amount of paper actually used by the class out of the total amount discarded each day.

If waste paper is incinerated, discuss the content of the final discharge. Ask about its effect on the atmosphere. Tell the students to think about the lifetime of paper as it goes from manufacture at the mill to the incinerator. How does the lifetime of paper compare to the lifetime of the trees from which it was made?

Relate the use of paper to other factors in the classroom.

Discuss the use of ink, chalk, paint, glass, heating fuel, fabrics, plastics, water, and even land that relates to the use of paper in a modern classroom.

Now tell the students investigations such as this are most useful if they teach not only awareness, but also a way to improve. Ask the students to suggest ways to reduce paper waste. If you make it a practice to permit students to use only one side of a sheet of paper, consider dropping it. Perhaps many assignments now turned in on paper need not be. Suggest ways that used paper can be re-used, as for drawer linings, wrapping, packing, etc. Ask the students to suggest other ideas.

At the end of the activity, tell the students that this exercise can be used with resources other than paper. They may, you might suggest, want to pursue a similar activity on their own that deals with water use or oil production. Be sure to point out that the uses of all resources should be considered in the light of their total impact on the environment.

TITLE: Heat Retention

CONCEPT: The production, use, and conservation of energy is essential in the maintenance of our society as we know it.

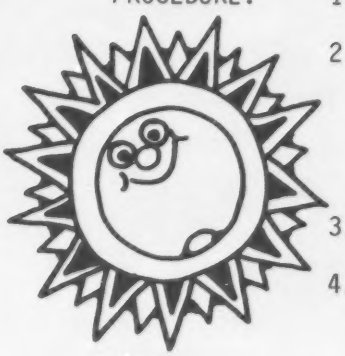
PURPOSE: To demonstrate why the color of the roof and walls of a house can be important in determining the amount of heat and air conditioning the house will use.

BACKGROUND INFORMATION: One of the most important single steps in residential energy conservation is the selection of roof color and wall color. Dark colors absorb and light colors reflect the heat.

By selecting the right colors before construction or when reroofing and remodeling, you immediately begin to earn dividends in the form of reduced utility usage. Even though utility costs rise as energy prices increase, the rise will be much less than it would have been without proper selection of color.

MATERIALS:
four juice cans
poster paint - white, black, green, red
hot water (close to boiling point)
four thermometers
food coloring

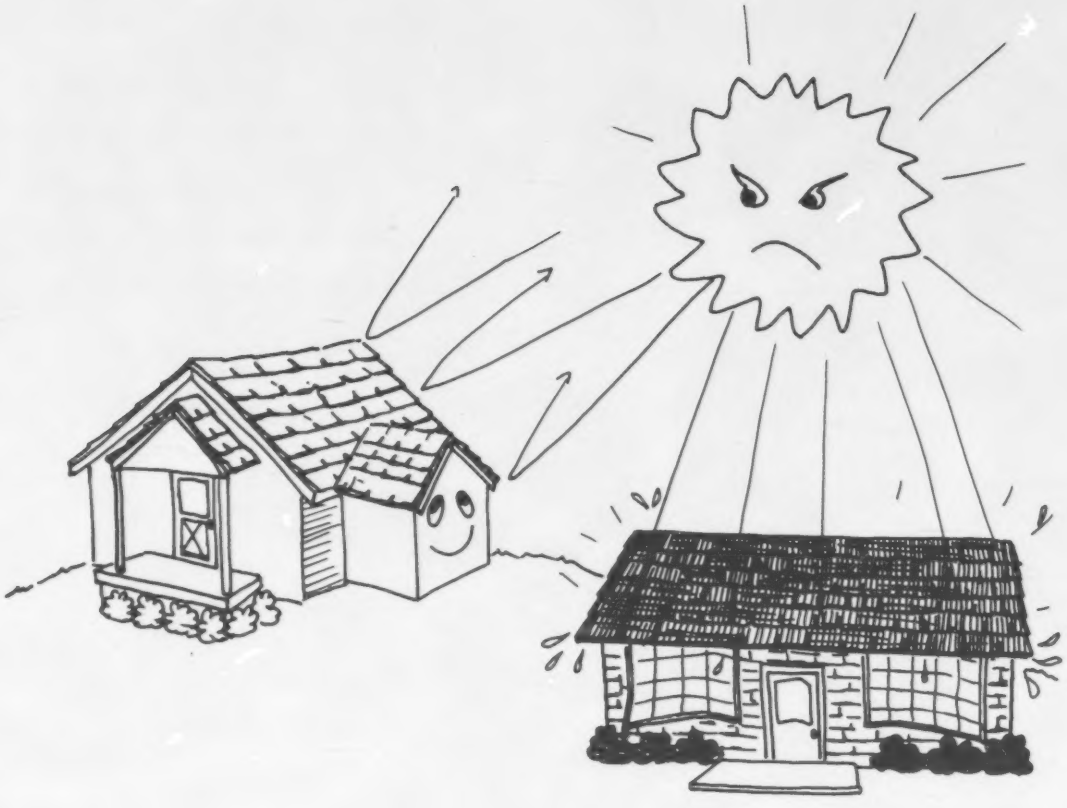
PROCEDURE:



1. Paint each can a different color.
2. Fill each can with the same amount of water. Add food coloring to the hot water corresponding with the color of the can. NOTE: Add drops of all colors together to get black, and add no color to the water in the white can.
3. Put a thermometer in each cup.
4. Record the temperature of the water in each can every 3 minutes until the water cools. Make a graph of the results.

DISCUSSION:
1. Which color held heat best?
2. What is the best color to paint a house to keep it warm in the winter?
3. Would a house with a dark roof be more or less expen-

sive to air condition in the summertime? the winter-time?



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TITLE:	Car Count
CONCEPT:	The automobile is about the least efficient vehicle for moving people.
PURPOSE:	To investigate the number of cars and passengers passing an intersection during a given block of time.

MATERIALS: (student quantities)
pencil
paper

PROCEDURE: Take a fuel consumption survey by counting all cars, trucks, buses, etc., that pass a predetermined point in a 35-minute time period. (Time may vary, but should be monitored to make the data useful.)

1. Go to the site.
2. Count and record all vehicles and number of passengers.
3. Tally the results.
4. Divide the number of people by the number of vehicles to find the ratio of cars to people.

DISCUSSION FOLLOW-UP: Cars use an average of 3400 BTU per passenger mile, but in town, that usage jumps to 8100 BTU per person per mile. How many BTUs were consumed in the 30-minute time period?

FOLLOW-UP ACTIVITY: Each year for over a decade, the Hertz Corporation has published an annual report detailing the costs of owning and operating passenger cars and trucks. The report released in November 1979 assumes the car will be owned for three years and will average 10,000 miles per year.

Ownership and operating cost cover: gasoline, oil, and other service station items, maintenance, parts, and repairs, license fees, insurance, and car loan interest, plus depreciation.

SUBCOMPACTS (e.g. Pinto)
Cost: 30.1¢ per mile (up 16.7% over 1978)

COMPACT (e.g. Fairmont)
Cost: 31.9¢ per mile (up 13.1% over 1978)

INTERMEDIATE (e.g. Granada)
Cost: 36.6¢ per mile (up to 12.3% over 1978)

FULL SIZE (e.g. LTD)
Cost: 43.4¢ per mile (up 17.3% over 1978)

EXAMPLE: If your parent(s) commute to and from work for a total of 50 miles per day and have an average 21-day work month... 50 x 21 = 1,050 commuter miles per month. On the basis of the costs per mile and class of vehicle, the true costs are:

Subcompact	30.1¢ x 1050 = $316 per month
Compact:	31.9¢ x 1050 = $335 per month
Intermediate:	36.6¢ x 1050 = $384 per month
Full Size:	43.4¢ x 1050 = $455 per month

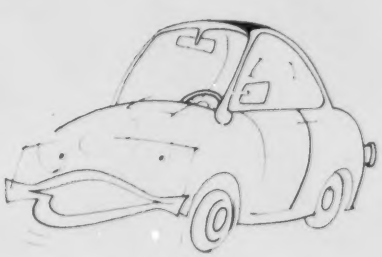
*** QUIZ ***

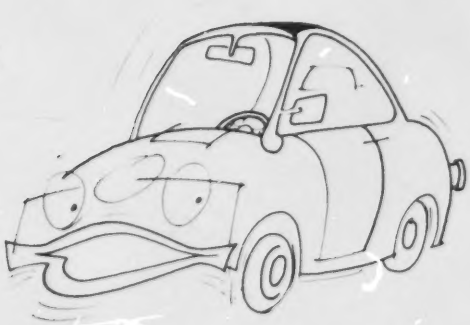
YOUR FAMILY CAR COSTS

(Round trip daily mileage)_____ x 21 days = _____(monthly miles).

(Monthly mileage_____x (per mileage costs from above)_____¢ = $_____(monthly cost).

Car pooling can save energy as well as money!





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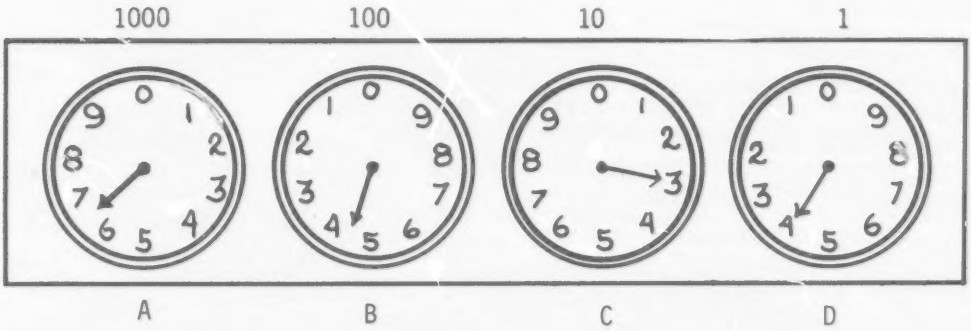
TITLE:	Read Your Meter
CONCEPT:	Usage is measured and can be controlled.
PURPOSE:	To learn how to read the electric and gas meters and to compute cost of usage. This might lead the student to some sucessful attempts at energy conservation.

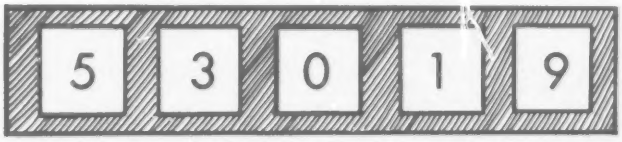
BACKGROUND INFORMATION:

Electric Meters: As the hand on the dial turns in a clockwise or counterclockwise direction, it counts as one unit of electricity used. The number of units counted is the last number passed by the hand. The reason for the four dials is that each dial can count only 10 units, so each dial will count as a unit of a different size.



In order to get the total reading of the electric meter shown, add together the readings on the dials A, B, C, and D. The meter reads 6534 kilowatt hours of usage. By obtaining the local rate from the power company and recording the readings at two given times, the student can calculate the usage and cost for his home or school.

Gas Meter: Gas meters are read the same as the electric meters except in units of cubic feet. Also, some large consumers have digital meters.



MATERIALS: (student quantities)
paper
pencil

PROCEDURE:

1. Students read their gas and electric meters at home each day at a prescribed time for a one-week period.
2. Compile readings in graph form.
3. Have students encourage their family to conserve usage of these utilities then take readings for another week.
4. Compare usage for the two-week period by graphing readings. Compute energy saved as well as money saved by implementing simple conservation methods.
5. Discuss additional ways of reducing utility bills.

TITLE:	Design a "Car-Free" Model City
CONCEPT:	"Today this country has more licensed drivers than registered voters, and two cars are produced for every baby born." (Figures adapted from National Energy Outlook, Federal Energy Administration, 1976.)
PURPOSE:	To investigate futuristic city planning with a transportation system dominated by a form of conveyance other than the automobile.

MATERIALS: six pieces of posterboard or butcher paper, 24" x 20"
magic markers
imagination!

PROCEDURE:

1. Divide the class into six groups.
2. Instruct members of each group to imagine that they are city planners and scientists. Consider new modes of clean, efficient transportation for a "no-car, no-truck" city. Decide beforehand if buses with gasoline engines will be allowed.
3. Each group will draw its model city to share with the class. Show the source of energy for its city (nuclear, ocean tides, solar, geothermal, imaginary).

TITLE:	Solar Cooking
CONCEPT:	Direct energy from the sun (solar) may be used to cook many foods. The energy is free.
PURPOSE:	To help the student recognize that solar energy has potential to become an important alternate energy source.

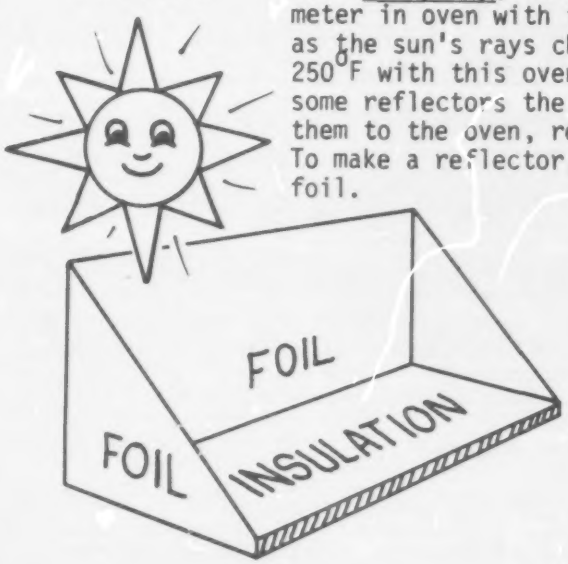
MATERIALS:

cardboard box
heavy-duty aluminum foil
fiber glass insulation
sheet metal or template painted with flat black paint
(Note: Paint must withstand high temperature)
oven thermometer
safety-glass cover (clear, not tinted)
dark pan for cooking
food to cook (slice-and-bake refrigerator cookies will do)
stiff cardboard or thin plywood for reflectors

Construction of Solar Oven: Measure 16 inches across the bottom of the box and 15 inches high. Cut box at 45° angle. Line inside of box with aluminum foil and cover outside of box with aluminum foil. Place a one-inch layer of fiber glass insulation inside the box (bottom, top, and sides). Use the sheet metal or template to make the inner walls. Paint flat black using paint which can withstand high temperatures. Cover the solar oven with glass. (NOTE: Duct tape to cover the edges of the glass will make it easier and safer to handle.)

PROCEDURE:

On a sunny day, face oven toward the sun. Place thermometer in oven with the food. Adjust the angle of the box as the sun's rays change. You can achieve approximately 250°F with this oven. To increase the temperature, make some reflectors the same size as the glass cover and tape them to the oven, reflecting more energy into the oven. To make a reflector, just cover material with aluminum foil.



TITLE:	Solar Motor
Concept:	When air is heated it becomes lighter and therefore rises.
Purpose:	To give the student insight to convection currents

Materials:

Two tall juice cans or coffee cans
Dull black spray paint
Paper clip
Straight pin
Paper to make a pinwheel
Two books or flat rocks
Tape
Sun lamp for demonstration, if no sunlight

Procedure:

Cut top and bottom ends from cans. Tape cans together and spray paint. Make pinwheel according to illustration, insert straight pin in center then tape to paper clip which has been bent. Tape paper clip to inside of top can. Set cans on books or rocks in sunlight. The warm air rises and will turn the solar motor (pinwheel).

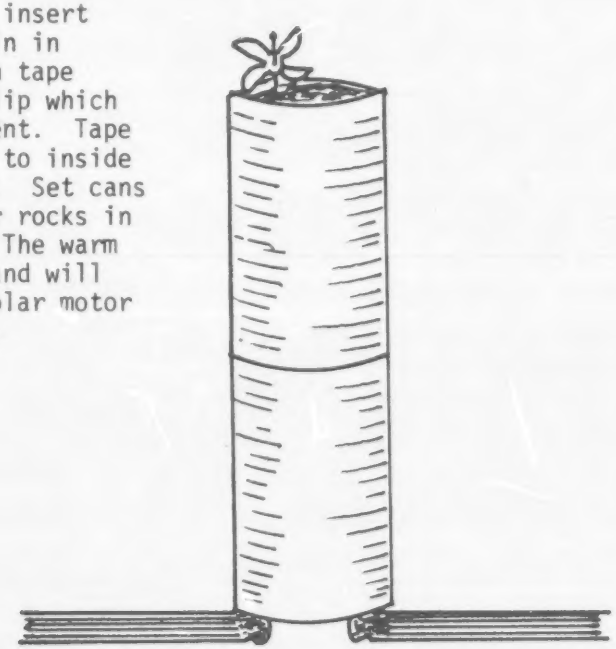


Figure 20

SIMPLE SOLAR COOKER

Few pieces of equipment show the power of the sun more dramatically than the cooker. The key element is the curved reflector which concentrates the solar rays upon the prospective meal.

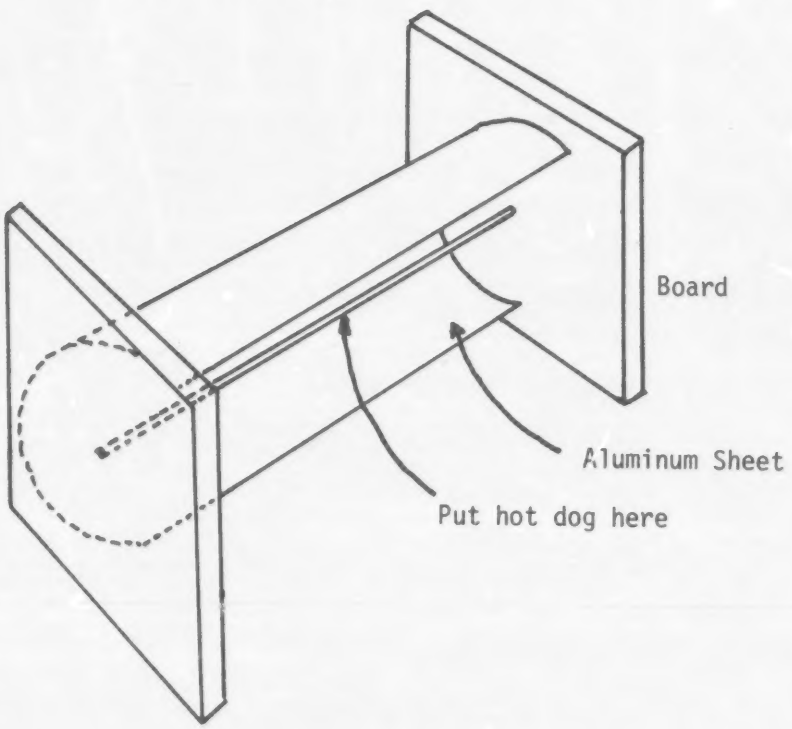


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Figure 21

TITLE: Solar Radiation

CONCEPT: The amount of heat depends upon the amount of light and the surface of the material reflecting the rays.

PURPOSE:

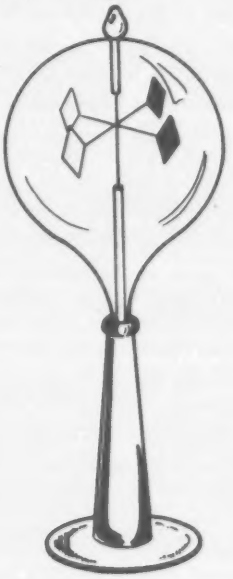
1. To help the student realize that dark surfaces enable a solar system to absorb a greater amount of heat. Conditions that affect absorption of solar rays are color of house, roof, solar collector background, car, etc.

2. To observe movement due to differing amounts of light.

MATERIALS:
radiometer
photographic light meter
large box
sheet of cardboard covered on one side with foil

PROCEDURE: Use different light conditions to take reading of amount of light and observe speed of radiometer vane as follows:

1. Full sunlight.
2. Partial shade (tree).
3. Full shade (radiometer placed in a box with open side away from sun).
4. Concentrated light (radiometer placed on folded foil-covered cardboard facing the sun).
5. Incandescent light.
6. Fluorescent light.
7. Flame.



TITLE:	Hot Rocks Can Be Sources of Energy
CONCEPT:	Hot spots below the surface of the earth can be used for an alternate source of energy.
PURPOSE:	To locate possible geothermal (gee-o-ther'-mal) energy sites in Oklahoma.

MATERIALS: Oklahoma State Highway map
Oklahoma geothermal map

BACKGROUND INFORMATION: Mankind has always been fascinated by natural phenomena such as volcanoes, geysers, and hot springs -- all manifestations of geothermal energy. Today, methods for using energy derived from the earth's heat are being actively explored. Geothermal energy -- abundant and relatively clean -- is one of many alternative domestic energy sources currently being developed to replace our dwindling supplies of oil and gas.

By tapping into and harnessing pockets of natural heat thousands of feet below the earth's surface, experts believe that the United States could develop up to 20 million kilowatts of electrical generating capacity over the next two decades. This would supply energy equivalent to about four percent of this country's present crude oil production.

Often at shallower depths of as few as hundreds of feet, geothermal resources can be used for direct heat applications such as heating homes and greenhouses, drying crops and wood, distilling ethanol for fuel, and processing food. Direct heat uses tap the large and abundant low-to-moderate temperature (less than 300°F) reservoirs present in many areas of the United States.

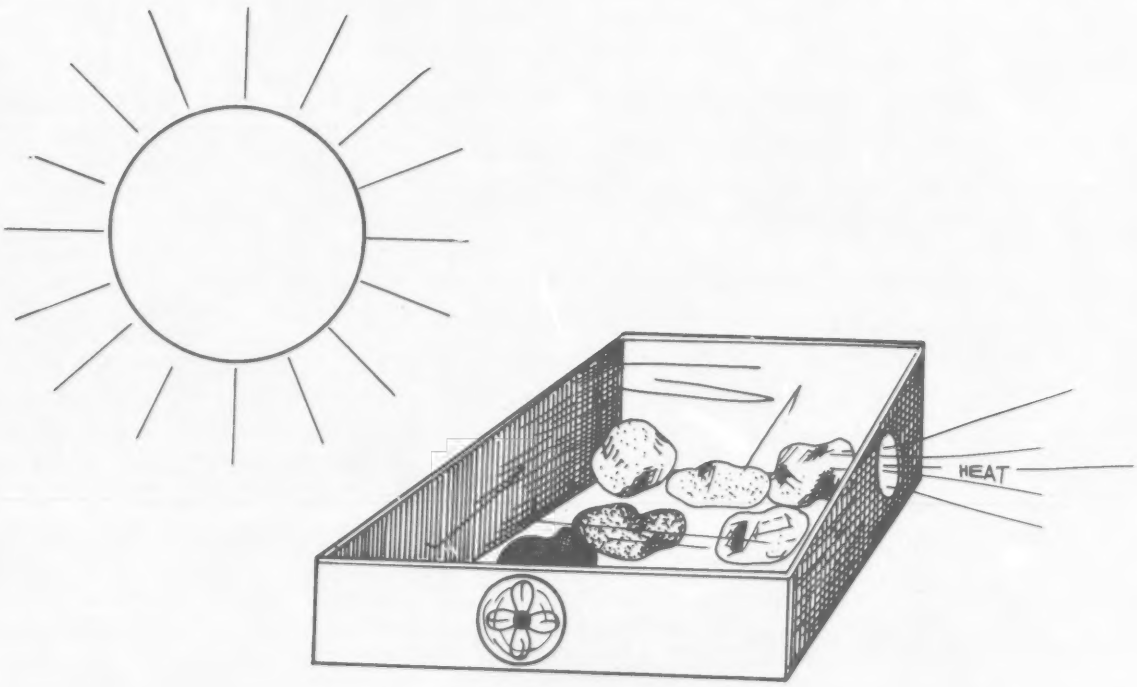
The production of geothermal energy, however, is not totally free from adverse environmental impacts. Measures for protecting the environment must go hand-in-hand with the development of geothermal technology.

Three broad types of geothermal resources are being considered for development in the United States: hydrothermal reservoirs, geopressured zones, and hot dry rock. Each type poses its own particular technological and environmental problems, and each specific site has its own special environmental impacts.

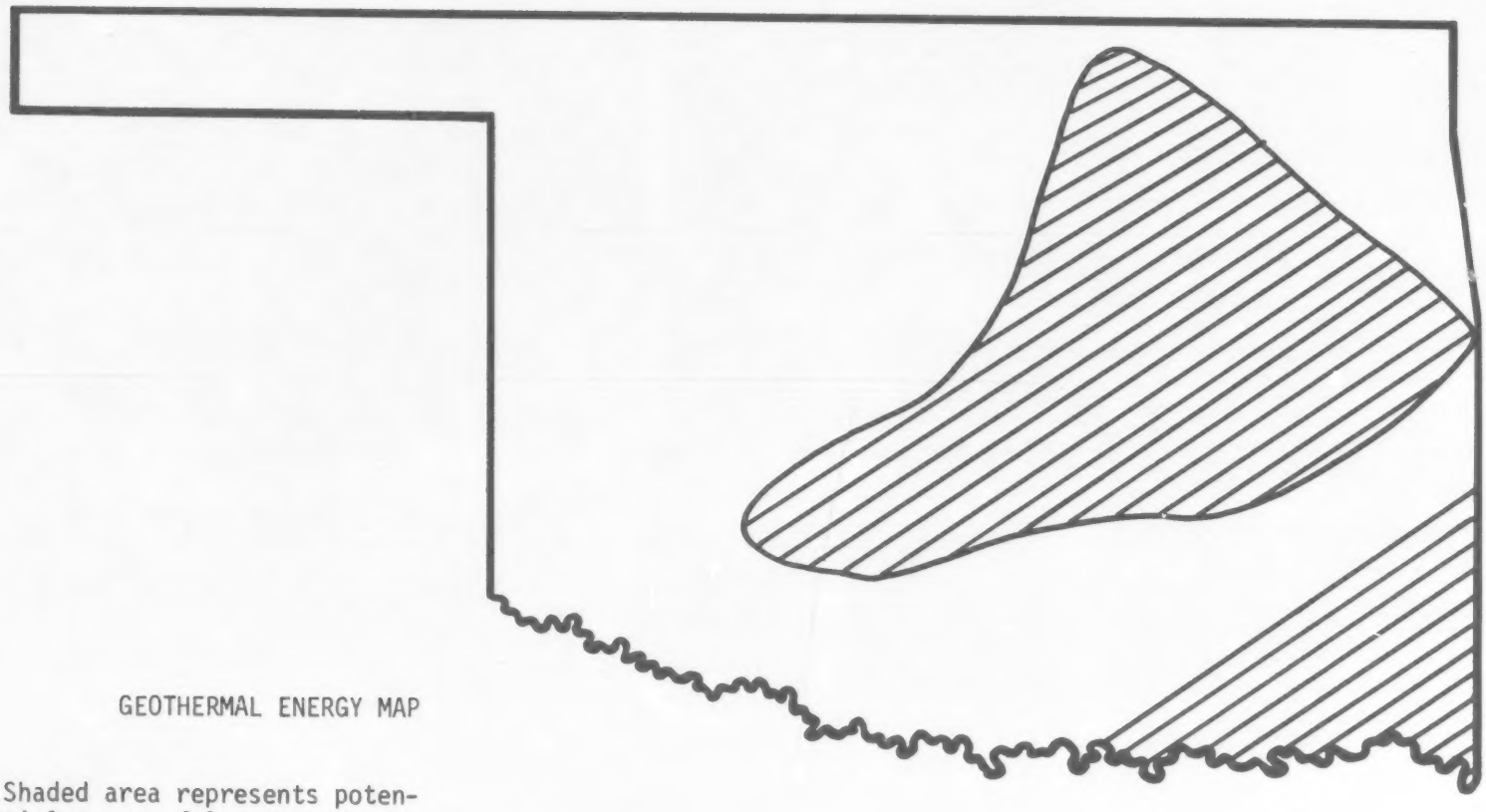
Although geothermal energy may provide only three to five percent of our energy needs by the year 2,000, it is one of the cleaner energy sources available and can make a valuable contribution toward satisfying both environmental and energy goals.

PROCEDURE: Using the two maps, determine if geothermal energy would be readily available at the following locations:

1. Guymon
2. Tulsa
3. Miami
4. Pauls Valley
5. Norman



GEOTHERMAL MAP OF OKLAHOMA



GEOTHERMAL ENERGY MAP

Shaded area represents potential zones of low to moderate temperature (less than 300°F).

Figure 22

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TITLE:	Meeting Tomorrow's Needs Today
CONCEPT:	The human population is expanding beyond carrying capacity of its environment.
PURPOSE:	Upon completion of this activity students will be able to describe long-range effects resulting from making a change in the environment.

MATERIALS: none

PROCEDURE: This exercise is an attempt to demonstrate to students that the abuse of limited resources will result in changes in a person's lifestyle.

Tell the students they are to pretend the classroom is an isolated cabin on a mountainside. It is winter, and outside the snow lies cold and deep. On the mountain slope, outside the windows of the cabin, they can see 15 fully grown trees. No other trees are around the cabin nor anywhere else on the surrounding land. The students need firewood and must decide whether to cut all the trees down during the winter to use them for firewood.

Now tell the students to decide what seems to be the best action to take. Ask them to consider:

1. What will happen next summer when it gets hot? (No shade.)

2. What might happen the following winter when more firewood is needed to keep warm? (No fuel for cooking and heating.)

3. What problems might there be for animals? (Fewer places for some birds and squirrels to live.)

4. What might be done to insure trees are left for the future? (Each time a tree is cut, two could be planted.)

During the discussion, emphasize to the students the differences between the short-term and long-term results of actions they recommend. Ask them to describe the long-range effects of any action they recommend.

TITLE:	Spaceship Earth: The Terrarium
CONCEPT:	Both man and wildlife exist in a closed system, "spaceship earth".
PURPOSE:	Students will have a better understanding of the meaning of "spaceship earth".

BACKGROUND INFORMATION: The atmosphere surrounds the earth like a big, thick blanket, enclosing the planet in a transparent sphere. In this respect, the earth is much like a gigantic aquarium into which comes only the sun's energy. No other resources are added.

A good model to use in illustrating the way in which the earth functions as a closed, aquarium-like entity is by making a model of the world in a glass container. This will be self-contained, draw energy from the sun, and be, in some respects, as isolated as a spaceship on a distant flight.

MATERIALS:
ground charcoal
aquarium
a plate of glass
gravel
soil
plants
water
paraffin
tape

PROCEDURE: To build the terrarium, put a layer of charcoal in the bottom of an aquarium or large jar. Put an inch or so of gravel on top of the charcoal for drainage, then several inches of soil. If you use a rounded container, the outside can be lined with sphagnum moss.

Now select some small, leafed plants to put into the terrarium. Plant taller plants at the rear and smaller at the front, water the soil to settle it and cover the terrarium with a lid. If you want, you can seal the lid with paraffin or tape, but let the terrarium sit a while before sealing, as the glass may cloud up at first. If the glass does cloud, remove the lid until it clears and let sit a while before sealing.

Place the terrarium in a window where it will receive

diffused light. Do not put it directly in bright light.

When discussing the terrarium with the students, point out how the water is transpired by the plants, condenses on the top and sides of the terrarium, and is used again by the plants. Emphasize that this is a closed system, with the sun serving as the only outside source of energy. Make it clear to the students that the earth itself is a lot like the terrarium, although the planet is surrounded by a "lid" of air rather than by glass.

FOLLOW-UP ACTIVITY:

To further demonstrate the nature of the earth as a closed system, you may want to test the effect of pollutants on the terrarium. Do not fail to note that large amounts of pollutants put into the earth's ecosystem will eventually have the same effect upon the earth that the admission of a pollutant into the terrarium has on it.

To pollute the terrarium, lift the lid and spray in a few ounces of gasoline. The gasoline should get into the water cycle and lead to the deaths of the plants. Provide some discussion that will indicate to the students the parallels between this destruction and that of the earth from pollutants.

TITLE:	Wind
CONCEPT:	Wind produces motion.
PURPOSE:	To construct a simple windmill and use it to observe wind speeds at different locations.

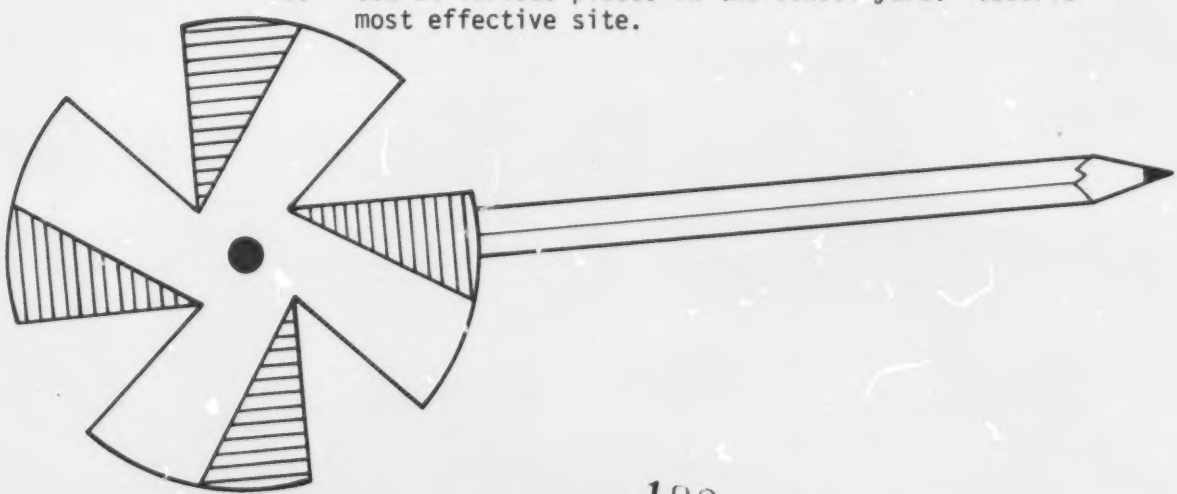
BACKGROUND INFORMATION: By the time today's junior high student reaches 22 years of age, natural gas may be unavailable. By the time he is about 35 years old, oil may be in severely limited supply (based on current rate of consumption and known reserves).

Could we use the wind to produce mechanical energy? Can we harness its force?

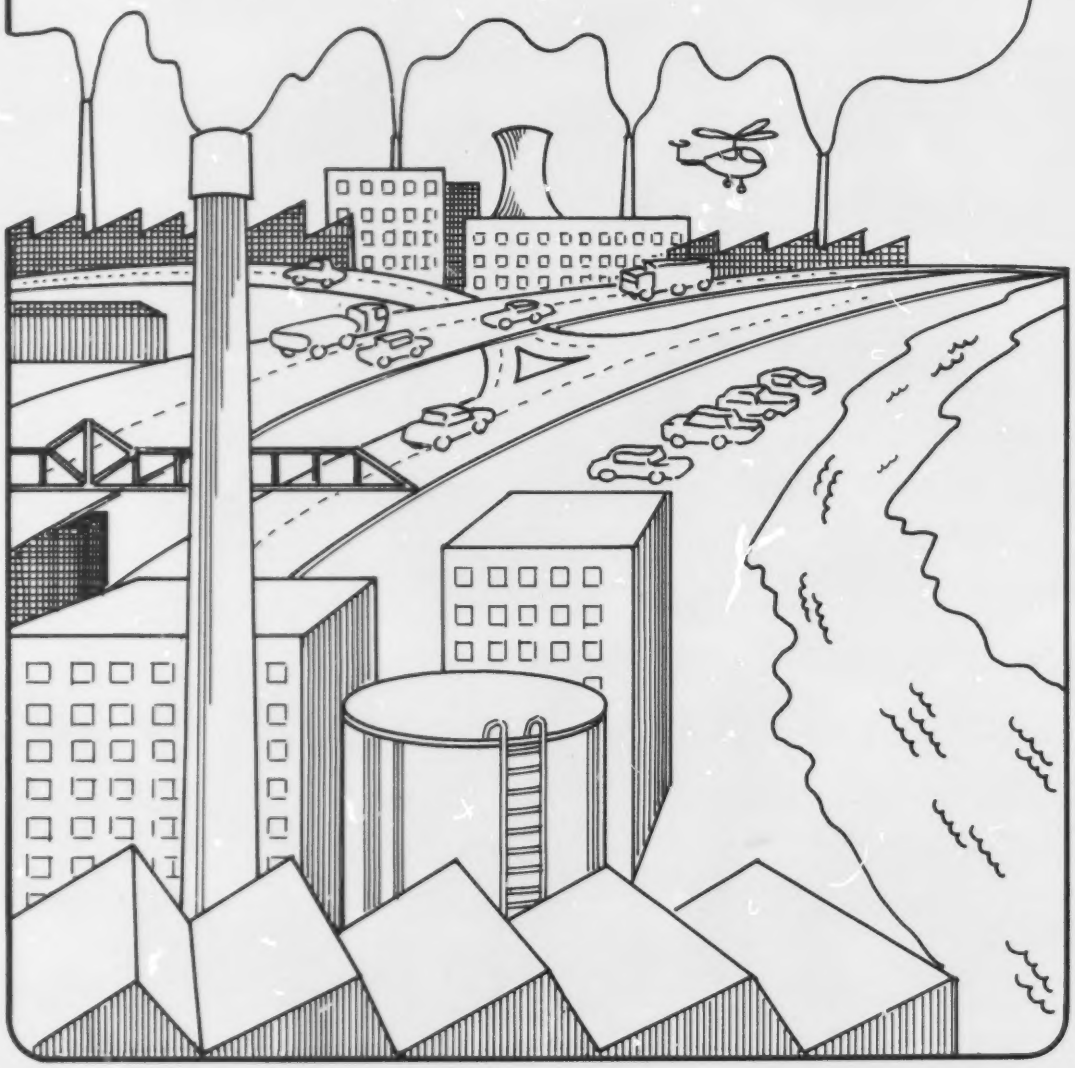
MATERIALS:
milk carton
scissors
pin
pencil with eraser

PROCEDURE:

1. Cut a circle from one side of a milk carton.
2. Draw two perpendicular lines, crossing at center.
3. Cut along lines to within 1/2 inch of centerpoint.
4. Fold each section so cut portion is at right angles to that portion remaining flat.
5. Push a pin through the centerpoint and into pencil eraser.
6. Use at various places in the school yard. Observe most effective site.



Environmental Health



CHAPTER 5

ENVIRONMENTAL HEALTH

The First Annual Environmental Quality Index for 1980 was released August 4th by the Oklahoma Wildlife Federation. (Outdoor News, August, 1980).

Eight of the major areas concerning environmental quality factors are: population, air, water, energy, land and forest, fish, wildlife, and outdoor recreation. Several of these areas have been explored in previous chapters, however, it is important that you realize that all of these areas contribute in their own way to your overall environmental health.

"I'm an Oklahoman" is said today with a great deal of pride.

That has not always been true. One does not have to search back in state's history many years before the ugly words "dust bowl" jump at you.

It was dusty and grimy back in the 1930's. Many gave up in disgust, refusing to fight Mother Nature for a living. Then the west-bound Oklahomans were named "Okies". Be thankful for those hardy people who decided something could be done to improve the conditions in our state. Their efforts through the years in conservation of our natural resources have resulted in the overall improvement of every area of life in the Sooner state.

But as Oklahoma grew ... so did science and technology, and this brought along new problems to our air, water, and land pollution, as well

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as human health hazards. These had to be dealt with for the protection of all.

Volunteer organizations such as the Oklahoma Wildlife Federation came into being. They have been a great aid in assisting federal, state, and local agencies in working towards solutions on matters that affect the health and well-being of Oklahomans.

It is an accepted fact that we are the most successful species to ever appear on this earth and Mother Nature acknowledges this success with the reward of allowing more members of our species to survive and consequently to reproduce, which means population growth.

A moderate but firmly established population boom is underway in Oklahoma. National population growth patterns reflect economic and population shifts from the nation's frostbelt to the sunbelt. Our population grew from 2,559,000 in 1970 to an estimated 2,892,000 in 1979. At current rates of growth, and maintaining current levels of migration and birth and death rates, Oklahoma's population is projected to grow to 3,698,000 by the year 2000. This means that Oklahomans will have to accommodate about 800,000 more persons during the next 20 years.

But nature says there will be a limit. At some point the environment will no longer support the population.

Human population growth is an extraordinary event. The population doubling time has grown shorter all through history. From the dawn of agriculture to the time of Christ, about 10,000 years, human population grew from about 5 million to 130 million, a doubling rate of about 1800 years. Today the doubling time is less than 35 years. Keep in mind that the world population today is 4 plus billion people.

The National Academy of Science has estimated that the earth might possibly support 30 BILLION people; however, conditions would be at a subsistence level only (the minimum as of food and shelter necessary to support life). Consider this --- that's only three doublings --- less than a century away -- a mere 5 generations. You can see that the results of this enormous population increase can be summed up in one word -- POLLUTION.

We must also keep in mind that (1) if the population expands faster than the economy, the economy cannot absorb the additional manpower; and (2) city crowding and the resulting polluted environment create uniquely human problems such as crime, litter, and unhealthy living conditions.

Air is an essential natural resource. It is reusable, cleaned by nature and by man to a limited degree. Man's role must be one of preventing air pollution.

Some air pollution is caused by natural occurrences such as volcanic eruptions, forest fires, and decaying vegetation. It is apparent, however, that most man-made contaminants stem from his use of fire -- to cook and heat, to generate electricity, to provide power for transportation and manufacturing.

"When the canary dies, it's time to get out of the mine!"

That expression was all too true a few generations ago. Miners took a canary underground to monitor the air. Its death warned of potential disaster due to an accumulation of carbon monoxide since the bird's size and metabolism (ma-tab'-a-liz-um) rate would cause it to die quicker than man.

Fortunately, such heartless detection methods are not needed today.

We have sophisticated devices to detect air pollutants resulting from a variety of sources.

The truth is, that regardless of recent dramatization, man's pollution of the air is not new. In 61 A.D., the statesman, Seneca, complained about the "soot and stink" of the heavy air of Rome. England's Queen Eleanor moved away from Nottingham Palace 700 years ago because of the unendurable smoke. And, in the 17th Century, it was written that Londoners breathed nothing but impure thick mist.

Ages ago before man added his contribution, nature was putting foreign matter into the air -- for good reason. It is essential to earth's life cycle. For instance:

(1) Volcanic ash and dust provide the nuclei for rainfall.

(2) Pollens propagate plant life.

(3) Various gases and mists, resulting from reactions caused by sunlight, humidity, and decomposition of plant and animal life, are essential to the continuing renewal of life sources.

In fact, nature constantly emits a far greater quantity of so-called air contaminants than does man. Her recycling processes, however, are uncannily self-cleansing. Given time, nature maintains a tolerable balance between polluted and acceptably-clean air, even with man's input.

Therefore, today's air pollution problems result from our persistent overwhelming of nature's self-cleansing capabilities in densely populated and industrialized areas, thus creating a temporary or continuing imbalance in nature's process.

Every method of air pollution prevention collects something which must be disposed of. Sometimes it is useful, such as sulfur removed from

smoke stack gases. In some instances, ashes can be converted into building materials. More often, however, the leftovers have no value and are generally used as landfill or are either treated before release into a sewer system or pumped into holding ponds. The captured material will settle, permitting the water to either evaporate or overflow into a sewer or stream.

Odors result from natural as well as man-made causes. Among the latter are fertilizing, tanning, brewing, manufacturing chemicals, textiles, pharmaceuticals, ore smelting, petroleum refining, food processing, sewers, dumps, lagoons, and settling ponds.

Odors are extremely prominent as a source of public resentment and, although most are not health hazards, nuisance laws to control them have been passed by a number of states.

While considerable progress has been made to measure odors mechanically, the final and most reliable device is the nose. All in-depth odor research is conducted by odor panels -- groups of individuals whose noses can determine the point of concentration of the odor where it can either be detected or where it becomes offensive.

It is obvious that clean air, as well as the food we eat and the water we drink, is the result of an endless process of chemical change.

According to the U. S. Public Health Service, the five man-made contaminants emitted in the largest quantities are:

Carbon monoxide - caused by incomplete combustion of gasoline from automobile exhaust

Sulfur oxides - combustion of sulfur-containing fuels such as coal or oil by power plants

Nitrogen oxides - from utility plants which provide our electricity or steam

Hydrocarbons and particulates - unburned or partially burned fuels and evaporation of industrial solvents, grinding, spraying, and combustion operations.

Most of these result from combustion -- man's use of fire to provide heat, power, transportation, and to dispose of refuse.

Although we do have some urban and industrial areas that have definite air quality problems, the Oklahoma State Department of Health, Air Quality Service is optimistic. Over most of the state the air quality is relatively clean and pure and something we can enjoy without undue concern ... and that's something that can't be said everywhere in this country.

Over the past few years, the state has established a water quality monitoring system to protect its citizens from water pollution.

Enforcement of regulations for municipal sewage treatment plants, industrial pollution, and use of pesticides and fertilizers where the pollutants can reach a stream as a result of rainfall runoff are only a few of the many problems faced in our state today.

Many of the fish kills in our rivers and streams are the result of industrial pollution. Hydro-thermal (heat and steam), petroleum production, and agricultural practices have all contributed to this problem.

Clean, safe drinking water is a necessity which most Americans take for granted. Yet the water supply across the nation and in Oklahoma is vulnerable to a number of unfavorable conditions -- some natural and some man-made.

About half the population of the United States depends on groundwater, that is, water that lies below the earth's surface in porous formations called aquifers (ak'-wa-fers). Aquifers are replenished as surface water gradually seeps down through the soil. Some of the groundwater, in turn, moves slowly underground and eventually feeds lakes and streams.

In Oklahoma, groundwater makes up more than 60 percent of the total water used. The state's rural dwellers are generally more dependent upon groundwater supplies than are urban residents, and those in the dry western counties rely on groundwater more than those in the heavy rainfall areas of central and eastern Oklahoma.

The economy of the state's western half is heavily dependent on agriculture, and this region encompasses about 80 percent of the state's irrigated cropland. Groundwater provides more than four-fifths of the water used for agricultural irrigation in Oklahoma, as well as meeting the domestic and industrial needs of some 300 cities and towns.

In central and eastern Oklahoma, surface water is plentiful and less demand is placed on groundwater reserves. Yet wherever groundwater is found -- whether it is presently used or merely a reserve water supply -- it must be protected from contamination. One potential source of groundwater contamination is a practice known as injection well disposal.

Underground injection is the placing of a fluid beneath the surface of the ground by injection down a well. It is a very useful technique with many applications; therefore it has become a practical solution to some very difficult disposal and storage problems. The liquid is stored in geological formations below the earth's surface by drilling through

layers of rock and sand and then injecting the liquids through the well into the formation. Shallow injection wells can be used to "recharge" aquifers with excess surface water. Deep injection wells can be used for waste disposal by injecting noxious (nox'-e-us) substances far below fresh water aquifers into geological formations surrounded by impermeable (m-per'-me-ah-bul) rock strata (stra'-ta).

Many large industries utilize the injection well disposal technique. For example, manufacturing plants inject chemicals, brine, and other by-products of the production process. But not all users of injection wells are large corporations. Small business operators often dispose of waste below the surface of the ground in trenches or pits on some unused part of their property. These shallow disposal sites are likely to be above water-bearing formations, and they pose a serious threat of contamination to the groundwater.

In Oklahoma, 17 industrial waste disposal wells and about 11,000 injection wells used for oil and gas recovery have been authorized and installed. But an untold number of unauthorized waste disposal wells are also in operation. Many of these wells hold toxic and hazardous waste, and are, if improperly constructed and managed, potentially harmful to Oklahoma's groundwater supply. With proper management, deep injection wells can safely be used for waste disposal.

The contamination of groundwater is a matter of grave concern. Groundwater is usually assumed to be of high quality and is often used with little or no treatment. Contamination is usually discovered when the consumer is taken ill and, in many cases, the only practical solution is to search for another water source. Because of the slow movement of

groundwater, it may be decades or even centuries before the aquifer is once more usable. In some cases, the contamination can never be reversed and the resource may be lost forever. Finally, the effort to clean up the nation's surface waters is hampered if the base flow of streams is already contaminated.

The Oklahoma State Department of Health encourages all citizens to take an active part in a team effort to protect fresh groundwater supplies. The purity of our groundwater cannot be left to chance -- particularly in Oklahoma, where so many people depend on it for their most basic needs.

In recent years we have seen the recreation facilities within our state improved. New state parks have been developed, progress has been made for scenic river protection, and unique natural areas have been set aside for recreation and environmental education.

Unfortunately, the majority of Oklahoma's public lands are located in the eastern part of the state. The distribution of recreation areas in western Oklahoma is limited by the availability of resources. This leaves a large portion of the population a great distance from the larger recreation areas and lakes.

We have seen an overall increase in such outdoor activities as hiking, trail riding, canoeing, fishing, and hunting, but there is still a need for more short-outing areas such as bike paths, nature trails, and urban nature sanctuaries.

The environments most accessible and meaningful to students are their immediate surroundings -- the school buildings and grounds, and the local community. Keep in mind that individuals working together can

effect change. In most cases, suitable areas can be located to set up an "outdoor classroom" which will benefit the entire school as well as the community.

Individuals must become aware that today's actions (or inactions) are major factors in determining the quality of the environment future generations will inherit.

Our soil, water, wildlife, range, and forest resources are limited and can be lost without conservation practices. How they are to be used is a choice only you can make.

TITLE:	Where is Everybody?
CONCEPT:	Environmental health is determined by our actions as well as our inactions.
PURPOSE:	To demonstrate the relationship of the population structure of the State of Oklahoma to environmental health.

MATERIALS: road maps of the state, current and 10 years old

PROCEDURE:

1. Using road maps, determine the current population of your community and the population 10 years ago. What factors could possibly account for this difference?

2. Interview persons who lived in the area 10 years ago and learn of the differences in land use. Pool information and prepare a chart comparing then and now. What effect does each item listed have on the air quality, water quality, waste disposal, energy demands, and carrying capacity of the land?

3. Are there indications that the changes were the result of environmentally sound planning? Give examples.

4. What characteristics were responsible for the development of large populations in Tulsa and Oklahoma City and small populations in Konawa and Talala? (Before a place is considered urban, a population of 2,500 is required.)

5. In 1975, more than 70 percent of all people lived in urban areas and the proportion is increasing. What are the advantages of living in an urban area? Disadvantages? What factors might cause the trend of urban living to reverse?

QUESTIONS TO CONSIDER:

1. What are some possible effects of a large town on a river?

2. What are some possible effects of an agricultural area on a river?

3. What are some possible effects of a chemical plant on a river?

4. What are some possible effects on a river that passes through an urbanized area?

* * * * *

TITLE: The Good News and the Bad News

CONCEPT: Many industries contribute to pollution in the community.

PURPOSE:

1. To help the student become aware of the sources of pollution in his community.
2. To encourage the student to take an active role in the monitoring of and political processes concerning pollution sources in the community.

MATERIALS: large map of your city (possibly produced with opaque projector)
multicolored map pins

PROCEDURE:

1. Mount a sizeable map of your community on a bulletin board.
2. Use map pins of one color to locate students' homes and the school.
3. Begin the process of determining point source pollutants within and bordering the community.
4. Use a single color of map pin for each type of pollutant, e.g., blue for oil, red for insecticide, green for fertilizer, orange for thermal pollution, yellow for hazardous chemicals, brown for silt, black for industrial aerial emissions, purple for noise pollution.
5. Number each pin.
6. Place a legend for identification of point sources next to the map. Use numbered references.
7. Communicate with responsible parties to learn how they are coping with the problem.
8. Remove the pin from the board whenever the pollution is cleared up.
9. Have a party! The good news is hard to come by.

QUESTIONS TO CONSIDER:

1. How does the population of your community affect the amount of pollution?

2. What benefits do you as an individual receive from the sources of the pollution? e.g., noise from an airport or emission from an industrial source.

3. Are these places in your community where you would not want to live solely because of the associated pollutants? If so, does anyone live there now? What do they think about the situation?

TITLE: Recycling Newspapers for Fun and Profit

CONCEPT: Our environment can be improved in many ways.

PURPOSE:

1. To make students aware of:
   a. the scope of the forestry industry in Oklahoma
   b. the mechanics of newspaper recycling
   c. the locations for recycling in their area
   d. the environmental impact of newspaper recycling.

2. To plant the seed of environmental stewardship as an integral part of the student's lifestyle.

MATERIALS:

storage space
grocery sacks
twine
pick-up truck, van, or station wagon
trailer (optional)
wooden flats (optional)

(Needs: Forestry map, recycling outlet list by counties, data on paper tonnage vs. trees used)

PROCEDURE:

1. Obtain principal's permission for the educational and fund-raising project.

2. Determine a suitable storage site. Floor space, traffic patterns, fire hazards, and accessibility should be considered.

3. Have each student establish a recycling station in his or her home. This may consist of a simple garbage sack stored in an accessible but out-of-sight location.

4. Place each day's discarded newspapers neatly into the sack.

5. When the sack is full (tightly packed), secure and tie a length of twine around it lengthwise.

6. Each time a bag is filled, bring it to school. (Be careful to do this before you become overloaded!) If you have a large amount of paper bundles, carry one to school each day until you are rid of them.

7. Set up a regularly scheduled day and time to take the bundles to the recycling plant.

8. Consult the list of recycling stations near your community and contact them concerning:
   a. location
   b. business hours
   c. rate of exchange
   d. bundling and materials regulations

9. Use the money collected for school programs (i.e., field trip expenses, equipment, a gift for the school, a science club project, etc.).

10. Expand the project to cover the entire student body. (Promotion will help a great deal. Posters, contests, bulletins, announcements, and intercom messages are effective.)

11. A "bucket brigade" approach to moving and loading the bundles of newspapers is quite efficient as well as fun.

QUESTIONS TO BE CONSIDERED:

1. What effect does newspaper recycling have on the lumber industry?

2. Why is the lumber industry non-committal on the idea of newspaper recycling?

3. How many trees does it take to produce the newspapers used on your block each week? month? year?

4. How many trees does it take to provide newspapers for your city for one year?

5. What happens to the ink?

6. Are there types of paper that should not be recycled? Why?

TITLE: The Sky is Falling

CONCEPT: There is particulate matter in the air.

PURPOSE: To gather data regarding air pollution by collecting particles which settle from the air.

PROCEDURE: Expose a glass microscope slide, coated with a thin film of petroleum jelly, at sampling sites. You should perform the investigation at several sites at the same time each day for several weeks. NOTE: Be sure to record the wind direction and velocity and other weather conditions at the time of each sampling.

NOTE: These sites might include construction sites, underground parking lots, industrial areas, airports, congested street areas, and residential areas. The length of time of exposure can vary every 24 hours. Select a given time for exposure and use it throughout the investigation.

EXAMINATION: Particulate materials can be analyzed under low power on the microscope. The origin and composition of a particle can be determined from its size, shape, color, and texture. Look for metal shavings, sand grains, dust, soot, pollen grains, animal hairs, etc.

1. Compare the results obtained from the various sampling sites.
2. How many different types of particles were you able to identify?
3. How do different samples from different test sites compare with respect to the type of particles and the relative distribution of particle size?
4. Account for variation. Can you suggest the most probable sources for these particles from your inspection of the sample?
5. Would this problem vary according to the season? Why?

QUESTIONS TO CONSIDER:

1. What causes changes in pollutants when they get into the air?

2. What are other types of air pollutants?

3. What legislation is necessary to reduce air pollution?

4. What research is being done to reduce air pollution?

5. Why does improper burning of fuels produce waste of that energy?

6. The addition of particulate matter to the air from such sources as smoke stacks and automobile exhaust is gradually reducing the amount of sunlight reaching the surface of the earth. Predict, through reference to the carbon cycle, the long-term effects of the continued addition of such matter to the air.

7. What laws does your state have to control air pollution?

8. How does a community attack the problem of air pollution?

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TITLE: Ecosystem in a Jar

CONCEPT: Everything is hitched to everything else.

PURPOSE: To involve the student with a simple, workable, somewhat flexible group of living (biotic) and non-living (abiotic) components in a closed system.

MATERIALS: gold fish of small and consistant size (about 1 inch)
elodea (may be called anachris) available at aquarium stores

PROCEDURE:

1. You may wish to use several one-gallon jars. You may also wish to choose a particular variable to emphasize the delicate balance that must be attained.
   For example: Variable = number of fish
   or
   Variable = number of elodea.

2.

Jar One	Jar Two	Jar Three	Jar Four
sand, H_2O	sand, H_2O	sand, H_2O	sand, H_2O
one fish	one fish	one fish	one fish
no elodea	20 cm elodea	40 cm elodea	60 cm elodea

3. NOTE: With the one-gallon jars you may find that snails place too high a demand for oxygen. If you have an even light source or if you can place the jars near a window (but not in more than 90 minutes of direct sunlight) you may not need a bright, incandescent light.

4. If an organism dies, continue to observe the ecosystem! It is still operating!

5. Distilled water insures the integrity of your variable What variables would pond or aquarium water add?

6. Rinse your elodea thoroughly to minimize the amount of micro-organisms that enter your system.

7. Some micro-organisms will be present in your system anyway. Their effects may show up in your data without being noticed or explained by the students, and often will puzzle the students. Watch for this confusion and help guide them to the appropriate discoveries.

8. Make histograms (bargraphs) with data collected on longevity of organisms (animal) or growth (plant).

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TITLE:	Brighten Your Corner of the World
CONCEPT:	The culture of a group is its learned behavior in the form of customs, habits, attitudes, institutions, and lifeways that are transmitted to its progeny.
PURPOSE:	To help students take personal responsibility for beautifying and maintaining the appearance of their school yard.

ACTIVITY:

Select a small number of classrooms and involve the students and their teachers in planning, developing, and maintaining flower beds or other planted areas which will beautify the school grounds.

Urge students to select plants which will be colorful, well-arranged, and at least some that will mature quickly. Solicit ideas, supervision, and support from parents who are interested in this type of project and who can work easily with students.

Make appropriate arrangements with principal, custodians, and parents to help students continue to be responsible for their annual plantings during summer vacation time.

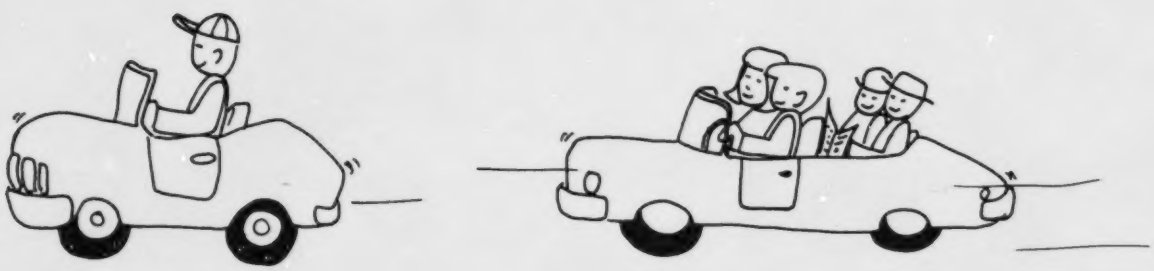
Take "before and after" pictures as well as during the actual planting process. Post these on the school bulletin board to keep the student body informed of your progress.

TITLE:	Aren't You Glad You Used Dial?
CONCEPT:	Carpooling makes sense.
PURPOSE:	To determine the extent to which carpooling is occurring in areas where it would be feasible.

MATERIALS:
pencil
paper
hand-held counter (or two students working together)

PROCEDURE:

1. Students should position themselves at entrances to school, factory or other industry, bank employee parking lots, etc.
2. Count the number of persons in each car passing your check point, also keep a tally of the total number of cars.
3. Determine the average number of persons per car.
4. Questions to consider:
   a. If there had been three persons per car, how many fewer cars would have been used? What might this represent in the way of fuel savings? What if there had been an average of four persons per car?
   b. Does carpooling deserve a reward? Suggest how the cars carrying multiple persons could be given priority parking spaces.
5. Design a proposal for priority parking for carpoolers and present it to the school or to the company monitored.



TITLE:	Fitness-Like List
CONCEPT:	Regular exercise is an important part of our lives.
PURPOSE:	This activity helps students examine their most prized and cherished activities to see if they are exercising properly.

PROCEDURE:

1. Have the students make a list of 5 to 10 physical activities they enjoy. This list might include activities they play with someone else or activities they play by themselves.

2. When the lists are finished, explain the "coding procedure" to be used:

   a. A dollar sign ($) is placed by any activity that costs money to do.

   b. an asterisk (*) is placed beside any activity that has been done within the last week.

   c. An (R) is placed by any activity which has an element of risk involved.

   d. An (S) is placed by an activity which involves speed to perform better.

   e. An (M) is placed by any activity which involves muscular strength to perform better.

   f. An (A) is placed by any activity which involves ability to perform better.

   g. A (C) is placed by any activity which involves coordination to perform better.

   h. An (E) is placed by any activity which involves endurance to perform better.

DISCUSSION:

1. What does regular exercise do for our body?
2. What kinds of exercise are good for us?
3. What are the benefits of outdoor exercise such as walking, hiking, jogging, etc?

TITLE:	Natural Recycling in Soil
CONCEPT:	There is a natural recycling (reuse) of earth's resources that prevents the depletion of essential raw materials.
PURPOSE:	To compare the natural recycling process of dead vegetation in different types of containers buried in the soil.

MATERIALS: for the class:

- scales or balance
- ball of string
- trowels or other digging tools

for each group:

- about ½ kilogram of dead vegetation (collect in study area or get discarded leafy vegetables from a supermarket)
- bag which larger scavengers can't get into (nylon net, pantyhose, etc.)
- bag with larger holes that scavengers <u>can</u> get through (hairnets)
- plastic bag with no holes
- stake or marker flag
- pencil

PROCEDURE:

1. Distribute materials. Weigh out three equivalent samples of dead vegetation and place one sample in each bag. Bags may be weighed empty so that this weight can be corrected later.
2. Close the bags and tie firmly. Dig a hole big enough for all three bags. Place bags in the hole all at the same depth and separate them from each other by at least 5 cm of soil. Cover the bags with 5 cm of soil and mark the site with a stake.
3. If desired, bury three empty bags as controls.
4. Allow 2-8 weeks before recovering the bags. Dig up the bags, weigh them, and inspect the contents.
5. Compare and discuss the results. Stress the concept that the vegetation that was lost from the bags did not simply disappear, but that it is being used by soil organisms and is being recycled through the ecosystem. Record the results in a table like the one on the following page.

	weight			appearance of contents	
	before	after	difference	before	after
container					
nylon stocking					
mesh bag with large holes					
plastic bag					

DISCUSSION QUESTIONS:

1. Does the type of bag influence the amount of change? Can you explain the changes?
2. What would happen if dead leaves did not decompose?
3. Was there a difference in the weight of the control bags before and after the experiment? If so, why? What effect does this have on your experiment?
4. Could the "wetness" of the soil in which the bags were buried have any affect?
5. What affect do you think the type of soil may have on the decomposition?
6. Where did the vegetation go that was lost from the bags? (Emphasize that it did not simply disappear, but is being reused.)

FOLLOW-UP ACTIVITIES:

Repeat the experiment using only one kind of mesh bag. Fill and weigh four bags. Place one bag about 8-10 cm above the soil (hanging from a stake), place one on top of the soil, and bury one about 8 cm below the soil surface. A fourth bag can be buried deeper. Mark each site with a stake or flag.

After 2-8 weeks, recover the bags, weigh them, and visually compare the contents.

TITLE:	Out of Control
CONCEPT:	A man-managed ecosystem will change if the influence of man is removed.
PURPOSE:	To observe the changes that occur in a lawn community when maintenance practices are discontinued.

MATERIALS: for the class

fence (to identify out-of-control area)
meter sticks
hand lenses
wire for quadrants
collection cups
paper and pencils
poster board or large sheet of white paper and markers

PROCEDURE:

1. Secure permission and notify the person in charge of maintentance for the area to be studied. Mark off the area in which maintenance will be discontinued (10 sq. m is adequate).

2. Stress two points to students:

   (1) A lawn is an expanse of grass spiced with a variety of animals and weedy plants.
   (2) A lawn is continually managed by man.

3. Have students identify as many lawn maintenance procedures as possible (mowing, watering, fertilizing, weeding, etc.). Discuss possible effects of eliminating these practices.

4. Ask students "how can we test these predictions?"

5. Make charts on the poster board and keep records of specific changes that occur, such as height of plants, number and kind of weeds that appear, number of lawn grasses that disappear, changes in animals present.

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TITLE:	There's a Hole in the Bucket!
CONCEPT:	The number of animals in an area is determined by the availability of food, water, and cover.
PURPOSE:	Upon completion of this activity the student will be able to: 1. explain the meaning of limiting factors; 2. demonstrate understanding of carrying capacity and limiting factors through discussion.

MATERIALS:
- bucket or pail
- crayons
- water
- corks or plugs

PROCEDURE: Using a plastic pail, jug, or milk carton make a display for this concept. Make three holes in the side of this pail, progressing towards the top.

Label each of these holes as illustrated. Tell the students the amount of water the bucket will hold is the carrying capacity for wildlife. The holes in the side of the bucket represent limiting factors.

Pour water into the bucket until it begins to run out the first hole. In this example water is the limiting factor for wildlife. The carrying capacity for wildlife is the amount of water below the first hole, and no matter how much water you pour in, the amount the bucket will hold is limited by this hole. Discuss.

Plug up the bottom hole. This represents the fact that water is no longer limited. Now pour water into the bucket again. Ask, "Now what becomes the limiting factor?" Food! Plug the food hole and pour more water into the bucket until it reaches carrying capacity. Shelter is now the limiting factor. Plug the shelter hole and add more water. Start a discussion of the wildlife habitat in your area and the capacity to carry a certain number of each kind of animal suited to live there. What happens to wildlife if a construction project suddenly removes its shelter? Pull the plug in the hole marked "shelter", etc.

Limiting factor is an ingredient of habitat, such as food, water, shelter, living space, that is deficient and prevents an animal population from increasing.

TITLE:	How Deep is Deep Enough?
CONCEPT:	Harmful pollutants must be disposed of in a safe manner to avoid contamination of ground water.
PURPOSE:	To develop an understanding of the importance of permeable and impermeable layers beneath the surface of the earth.

MATERIALS:
metric ruler
pencil
cross-sectional map of Oklahoma (see page following activity)

BACKGROUND INFORMATION:

Clean, safe drinking water is a necessity which most Americans take for granted. Yet the water supply across the nation and in Oklahoma is vulnerable to a number of unfavorable conditions -- some natural and some man-made.

About half the population of the United States depends on groundwater; that is, water that lies below the earth's surface in porous formations called aquifers. Aquifers are replenished as surface water gradually seeps down through the soil. Some of the groundwater, in turn, moves slowly underground and eventually feeds lakes and streams.

In Oklahoma, groundwater makes up more than 60 percent of the water used. The state's rural dwellers are generally more dependent upon groundwater supplies than are urban residents, and those in the dry western counties rely on groundwater more than those in the heavy rainfall areas of central and eastern Oklahoma.

In central and eastern Oklahoma, surface water is plentiful and less demand is placed on groundwater reserves. Yet, wherever groundwater is found -- whether it is presently used or merely a reserve water supply -- it must be protected from contamination. One potential source of groundwater contamination is a practice known as injection well disposal.

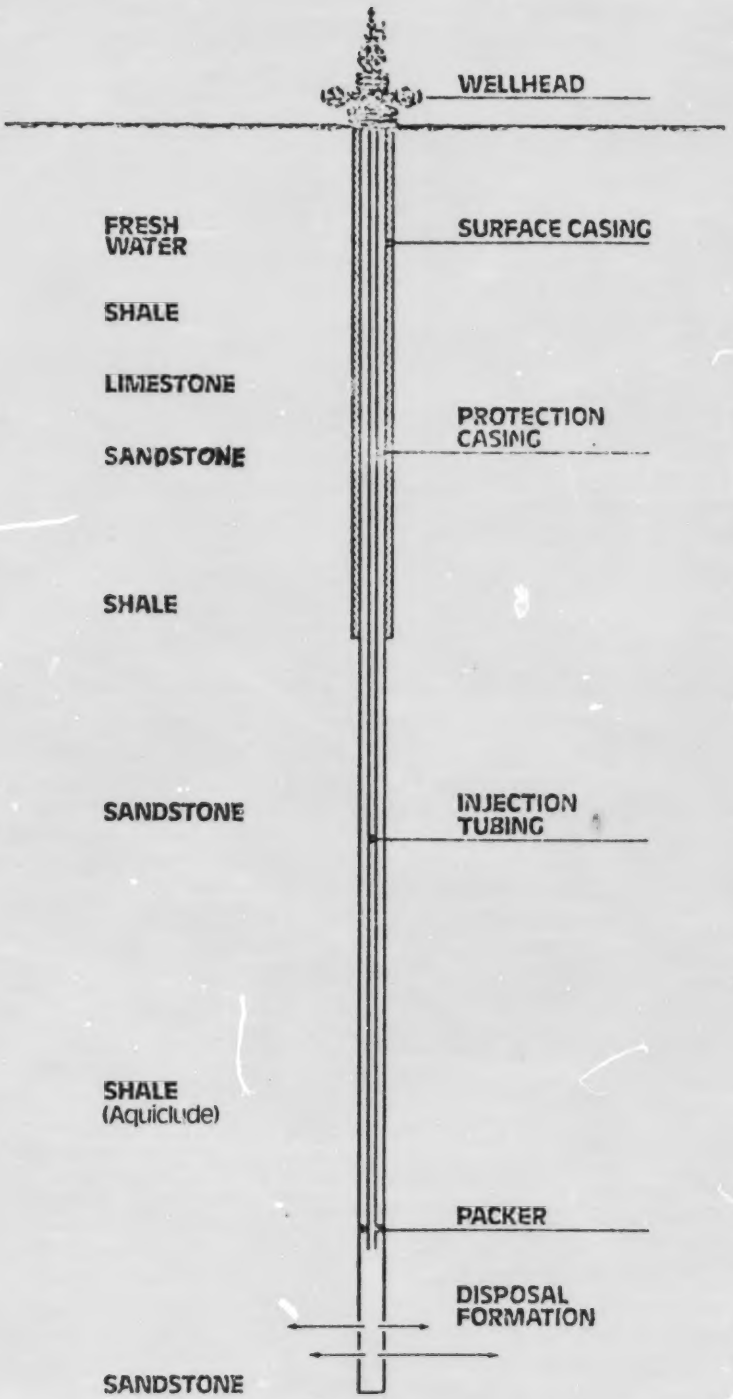
An injection well is a mechanism for placing or storing liquids in geological formations below the earth's surface by drilling through layers of rock and sand and then injecting the liquids through the well into the formation. Shallow injection wells can be used to "recharge" aquifers with excess surface water. Deep injection wells can be used for waste disposal by injecting noxious substances far below fresh water aquifers into geological formations

surrounded by impermeable rock strata.

PROCEDURE: Using a measurement of 1 cm = 10 ft., what is the minimum depth an injection well must be dug at point "X" in order to reach a safe disposal zone?

At what depth would you find potable (drinkable) water?

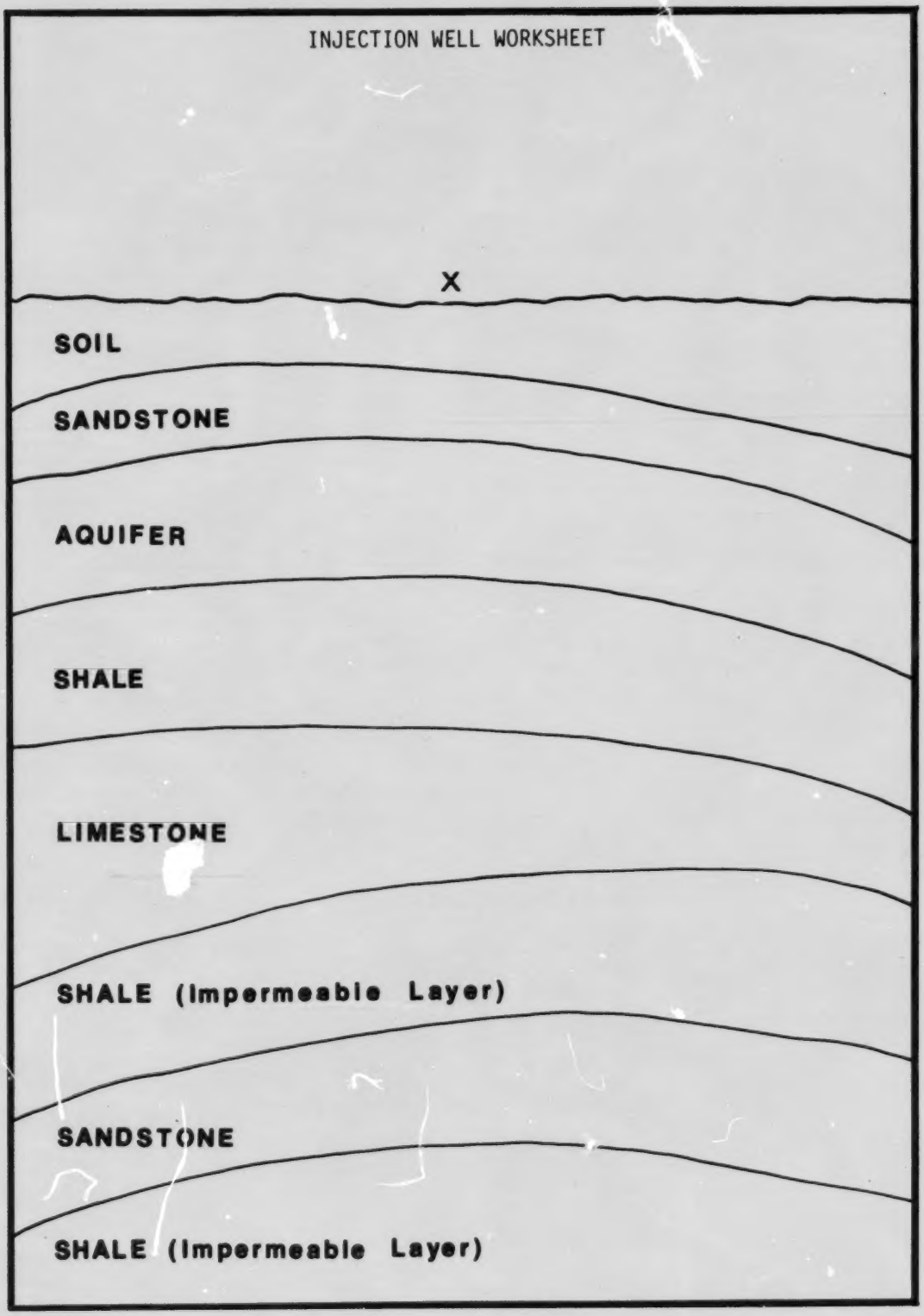
How thick is the aquifer?



Injection Well

Figure 23

INJECTION WELL WORKSHEET



TITLE:	Eco-Community Relationships
CONCEPT:	Living things are interdependent with one another and their environment.
PURPOSE:	To increase powers of observation and to become more aware of the continuous motion of living interactions in a community.

ACTIVITY: Solitary observation of ecological interactions.

The purpose of this activity is to give the student time to observe alone many of the living ecological interactions which might be missed while in a group.

1. Find an isolated spot away from other people and sit quietly for 30 minutes (or a suitable period of time).

2. Listen for sounds. Record all sounds that are heard and attempt an explanation of the source.

3. Record all smells. Attempt an explanation.

4. Record all that is seen. Look for the behavior of small animals (ants, pill bugs, birds, etc.) in the area. Try to determine what these animals are doing. Look for a pattern in the distribution of vegetation. What may be causing such a pattern -- light, drainage, trees in the area?

An interesting variation of this activity is to have the student select a particular insect or other animal and follow it for 20 minutes. Keep a record of all the animal does and attempt explanations for its actions.

After the activity is completed, have the students write a paper indicating all the observations they have made. Attempt an explanation of each activity of the animal. In a summary paragraph, have the student evaluate the exercise regarding solitary observation as opposed to group observation.

"Eco-Community Relationships", Investigations in Ecology, Copyright 1972, by Schultz and Marcuccio. Used with permission of the publisher, Charles E. Merrill Co., Inc., Columbus, Ohio 43216. All rights reserved.

TITLE: The Last Straw

CONCEPT: We can make sensible use of non-renewable energy by re-using "disposables."

PURPOSE:

1. To develop an awareness on the part of the student of the origin of many modern everyday conveniences - specifically the plastic soda straw and the styrofoam egg carton.

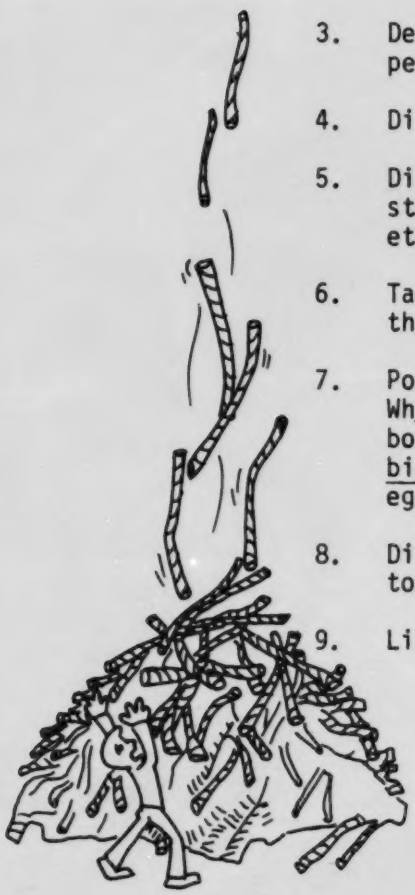
2. To stimulate the student's creativity in finding useful alternatives to disposing of "disposables."

MATERIALS: several boxes of plastic soda straws
scales (lab)

PROCEDURE:

1. Determine the number of plastic straws used by the class in one week.

2. Do the same for the entire school, city, state, and nation.



3. Determine the number of straws used in your school per year.

4. Discuss alternatives to the plastic straws.

5. Discuss alternate uses for "used" straws, e.g., plant stakes, model construction (art), toys, insulation, etc.

6. Take a walk around the school grounds and collect the used straws.

7. Ponder the fate of the used styrofoam egg carton. Why was there a switch from cardboard and press-board? Is styrofoam a petroleum product? Is it biodegradable? Are there other uses for used foam egg cartons?

8. Discuss the change from cardboard and wax milk cartons to oil-based plastic milk jugs.

9. List alternate uses for the plastic jugs.

APPENDIX

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APPENDIX: GLOSSARY

algea	Any plant of a group that forms the lowest division of the plant kingdom and includes seaweeds and related forms mostly growing in water
aquifer	Any geologic formation which is capable of yielding usable quantities of ground water
biotic	Caused by living beings
brachiopod	Any of a phylum of marine invertebrate animals with bivalve shells and a pair of arms bearing tentacles
Cambrian	The earliest period of the Paleozoic era marked by fossils of every great animal type except the vertebrate and by scarcely recognizable plant fossils
Cenozoic	The most recent of the five eras of geological history that extends to the present time is marked by a rapid evolution of mammals, birds, grasses, shrubs, and various flowering plants
concentric	Having a common center (concentric circles)
concretions	Minerals sometimes tend to concentrate in certain parts of a rock, often accumulating around a nucleus. The masses so formed may be rounded or irregular
coniferous	Cone-bearing trees, mostly evergreen
copalite	A resin found in rocks
deciduous	Falling off (as at the end of a growing period or stage of development)
diurnal	Recurring every day; having a daily cycle; occurring in the daytime
ecosystem	The association of all living and nonliving things in a community
epoch	An extended period of time characterized by a distinctive development, a division of geologic time less than a period and greater than an age

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eras	One of the major divisions of geologic time
finite	Having a limited nature or existence
geo	Earth; ground; soil
geothermal	Relating to the heat of the earth's interior
graphite	A soft black form of native carbon
ground water	Water that lies below the earth's surface in porous formations called aquifers
halite	Salt crystals
impermeable	Material that will not permit water or liquid to pass through
injection well	A mechanism for placing or storing liquids in geological formations below the earth's surface by drilling through layers of rock and sand and then injecting the liquids
invertebrates	Lacking a spinal column
meander	A turn or winding of a stream
Mesozoic	The fourth of the five eras of geological history marked by the existence of dinosaurs, marine and flying reptiles, and evergreen trees
metabolism	The sum of the processes by which a particular substance is handled in the living body
metamorphic	A change to a more compact and more highly crystalline condition produced by such forces as pressure, heat, and water
noxious	Harmful or injurious to health
Paleozoic	The third of the five eras of geological history which is marked by the culumination of nearly all classes of invertebrates except the insects and in the later epochs of which the seed-bearing plants, amphibians, and reptiles first appeared

permeable	Material that will permit water or other liquid pass through more or less freely to a lower surface
Permian	Marks the end of the Paleozoic era
photosynthesis	Formation of carbohydrates in the chlorophyll-containing tissues of plants exposed to light
plutonium	A radioactive metallic chemical element
porous	Has open spaces between mineral grains and can contain liquid
potable	Drinkable, safe to drink
Precambrian	The earliest era of geological history equivalent to the Archeozoic and Proterozoic
residual	Material left behind when part of a rock is removed by chemical weathering processes
respiration	A single complete act of breathing
sedimentary	Formed by or from deposits of sediment (limestone, shale, and sandstone are sedimentary rocks)
selenite	A clear gypsum crystal
strata	Rocks that display layering or bedding
topography	The art or practice of detailing on maps or charts natural and man-made features of a place or region especially, so as to show elevation
transpiration	To pass in the form of a vapor from a living body
trilobite	An extinct marine animal (that looked like a roly-poly) having a segmented body divided by longitudinal furrows on the back into three lobes

APPENDIX: TEACHER AIDS *

TRIGGER FILMS: A trigger film is a short, open-ended film which stimulates and generates discussion. The film may simulate a familiar situation and is followed by extensive classroom discussion. Alternative actions to the situation are discussed. The student thus has the experience to view a situation, consider alternatives, and make a decision. If the student comes upon a similar situation in life, he will already have had some experience in making such a decision.

Use of Trigger Films:

1. Introduce the film to the audience BRIEFLY.
2. Show the film.
3. Using the group as a whole (if the group is not too large) or dividing the group into smaller groups, discuss some thought-provoking questions. Discussion remains pertinent in all groups. Questions can be written on the board or handed out to all group members.
4. "Process" the film by bringing the group back together and discussing the major issues brought up in the smaller group discussions.
5. If time permits, the film could be shown again to reinforce group discussion.

Guidelines for the evaluation of a Trigger Film:

1. The film should be short and to the point. It should probably occupy no more than five minutes.
2. The information presented should be limited in amount. It is better to have too little information given than too much.
3. The objective of each film should be clearly delineated in advance and pursued diligently through classroom discussion. Side issues will detract from the desired outcome.
4. The situations should be realistic in terms of the viewer's frame of reference and likelihood of his encountering similar situations in the future.

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5. Points and issues should be presented simply and not belabored.

6. The situations should be open-ended, with many alternative sequels possible. There should be no sermon or moral. Complete stories and closure are to be avoided, as well as situations with "obvious" or clear-cut solutions. The purpose is for the viewer to generate feelings and ideas and to work through them, rather than to discover or arrive at any predetermined answers.

7. The termination point for the film should be the point for optimal triggering of reactions and discussion. It is difficult to define.

Advantages: The trigger film can be very useful for initiating learning situations and experiences in which the chief purpose is to generate ideas within the student as a means toward producing affective behavioral changes.

FILMSTRIPS:

Use of Filmstrips:

1. Introduce the filmstrip to the audience.

2. Show the film, stopping at appropriate spots if necessary.

3. Prepare some type of activity to serve as a follow-up to the filmstrip.

Guidelines for the Use of a Filmstrip:

1. The film should contain information appropriate to the grade level of the viewer.

2. Major points should be relevant to the topics being discussed; the filmstrip should be used to meet the objectives of the lesson, not just because it is entertaining or time-consuming.

3. The filmstrip should be obtained early enough to be previewed and also early enough to fit into the lesson at the appropriate time.

Advantages: "A picture is worth a thousand words." A filmstrip is useful because it can be stopped at an appropriate time for class discussion. Filmstrips which are purchased are not as expensive as a film, take little space and storage.

OVERHEAD TRANSPARENCIES:

Use of Overhead Transparencies:

1. Prepare the transparencies before the class meeting; this saves class time required to put information on the board.

2. When using a wax pencil to write on the transparencies, make sure the writing is legible and large when it is projected on the screen so that all can see. Also make sure that typed messages can be read throughout the room.

3. The overhead transparency is especially useful for information to be given to the students to be included in class notebooks.

Advantages: An overhead transparency can be cleaned and used over and over by the teacher for preparing class notes. It saves time and gives access to the material to all students in the classroom.

FACILITATING GROUP DISCUSSIONS

PURPOSE OF SMALL GROUP DISCUSSION:

1. Provides the opportunity for students to interact with peers and express their views in a less-threatening environment.

2. Provides the opportunity for students to consolidate their own learnings into concepts which will be valuable in the future and which can be integrated with other concepts.

3. Provides the opportunity for students to test the validity of their ideas through the reactions of the other students.

4. Provides the opportunity for students to make decisions before they are faced with the situations in "real life".

5. Provides the opportunity for students to develop skills related to group problem solving, such as setting clear goals, taking responsibility to contribute, encouraging others, careful listening, cooperating, and arriving at consensus.

6. Provides the opportunity for students to develop basic social skills such as respect for others and interpersonal communication.

PRELIMINARY REQUIREMENTS:

1. The teacher should begin with activities which develop trust, not only between student and teacher, but also among students.

2. The teacher should select activities which are non-threatening and which foster group interaction and free communication.

3. The teacher should establish ground rules: in discussing attitudes and values, there is not a right or wrong answer; each student has the right to "pass" on any activity; students should not be forced to participate.

STUDENT ASSIGNMENTS TO GROUPS/GROUP ASSIGNMENTS:

1. The discussion group should include five or six students.

2. Chairs should be arranged so that the students can look directly at one another. A circle is ideal; a horseshoe may have to be used in small spaces.

3. The random assignment of students to groups is preferable. Heterogeneous groups are more likely to do well on a task than homogeneous groups. However, during the earliest functioning of the group, sometimes it is better to let students pick their own groups.

ASSIGNING THE TASK:

1. The goal is the teacher's responsibility, but the students need to know precisely what they are expected to accomplish.

2. The teacher must make clear to the groups what task they are to work on and how long they have to accomplish it.

3. The task assignment is better accomplished in the large group.

4. A recorder for each group should be used to minimize group's deliberations.

5. If a group decision is necessary, work for consensus.

TEACHER ROLE:

1. The teacher should circulate among the groups to get them started.

2. If the teacher joins a group he/she should be seated with the group, rather than standing over them.

3. The teacher should refrain from calling on students; the teacher should not be the focal point of the conversation.

4. At the end of the assigned time period the teacher may: (a) leave the topic; (b) have groups share conclusions; (c) take time for teacher-directed discussion.

ADVANTAGES OF SMALL GROUP DISCUSSION:

1. Allows for involvement of all students.

2. Stimulates group interaction and participation.

3. Enables students to discuss common problems.

4. Allows students to become aware of opinions of their peer group.

5. Fosters creative thinking.

6. Gives students a feeling of worth by enabling them to identify their own problems.

TITLE: Student Self-Appraisal

CONCEPT: Self-appraisal is the most valuable form of evaluation.

PURPOSE: To be used in the evaluation of small group discussions.

PROCEDURE: Rate yourself according to the following scale:

5 = always
4 = most of the time
3 - about half of the time
2 = some of the time
1 = very seldom
0 = never

_____ 1. I contributed to the success of my group.

_____ 2. I was interested in the work of my group.

_____ 3. I learned from working with this group.

_____ 4. I communicated with others in the group.

_____ 5. I pulled my fair share of the load.

_____ 6. I offered ideas or thoughts that others could build on.

_____ 7. I contributed extra effort to ensure the success of the group.

_____ 8. I became personally involved in the group work.

TITLE: Is my Group Functioning?

CONCEPT: Analysis of group participation tends to improve overall learning in future activities.

PURPOSE: To be used in the evaluation of small group discussions.

5	4	3	2	1	0
Always	Most of the time	Half of the time	Some of the time	Seldom	Never

_____ 1. All members of my group participate.

_____ 2. There are many values and ideas expressed freely.

_____ 3. There seems to be trust among group members.

_____ 4. There seems to be acceptance of group members' ideas.

_____ 5. Our group is willing to initiate new activity and new ideas.

ROLE PLAYING

PURPOSES:

1. To allow students to take the roles of other people, so students may feel like, think like, and act like other people without risk of showing actual feelings. This tends to eliminate the risk of sanctions and reprisals.

2. To allow students to express feelings they might ordinarily keep hidden.

3. To allow students to be more spontaneous and creative with their feelings.

ADVANTAGES:

1. Role playing situations occur in a non-judgmental situation where "correct" solutions are not the goal.

2. Students can identify with the "real" worlds and imaginations of other students and adults.

3. When roles are examined and discussed by the entire class, students may make choices for their behavior when confronted with similar situations in the "real" world.

4. The increased opportunity for understanding oneself and others takes place during role playing situations. By practicing a variety of behaviors in a series of role playing exercises and by discussing the effects of each, students may be able to make more realistic choices for their actions than before.

5. The role playing technique is active. Participants and the other students do not merely discuss theoretical problems of behavior and alternative ways of acting, but they observe and practice new ways of behaving. The active participation in learning tends to enhance the learning itself. The necessary connection is made between knowledge and behavior.

PRELIMINARY REQUIREMENTS:

1. The problem or issue to be enacted in class may be structured by the teacher or by the students.

2. The situation must be clear, specific, and not too complex.

STEPS IN ROLE PLAYING SEQUENCE:

1. Preparation and instruction: This step includes

problem selection, general and specific instruction to participants and audience. An explanation of the general problem situation should make clear the educational purposes of the enactment. The teacher should also discuss the situation briefly with the participants so that they understand their role.

2. Dramatic action and discussion: This covers both the role playing itself and the evaluation which is done after the role playing. It is important to "process" the situation: evaluation of other choices of behavior must be made as well as bringing the students involved back to the real environment of the classroom. Focus should be made on the possible application of the examples to the student's interpersonal experiences.

3. Evaluation: In this final stage, teacher and students review the successes and failures of their role playing experience. The teacher will also want to make further personal evaluation of the experience in the light of the original purposes.

SETTING UP THE ROLE PLAYING SITUATION IN THE CLASSROOM:

1. Several different formats can be used for role playing in the classroom:

   a. Several groups may be role playing the same situation at once. A circle is formed with the chairs in the classroom, and the groups enact the situation as they perceive it.

   b. One group enacts the situation as the other members of the class watch.

   c. An individual is faced with a dilemma and role plays the alternate solutions.

2. Set the classroom up in the format desired.

3. Be sure participants and audience understand the situation.

4. Allow the scene to be enacted as long as purposes of the sequence are being met.

EDUCATIONAL GAMES

Educational games and strategies have been found to capture the imagination and enthusiasm of persons of all ages, especially students.

GUIDELINES FOR THE USE OF GAMES IN THE CLASSROOM:

1. Rules should be established before the game begins. Rules are usually the same as they are simulating (tic-tac-toe, Jeopardy, etc.). If the game is an original one, make sure all participants understand the rules.

2. There should be no penalty for not knowing an answer; points should be awarded for correct answers.

3. Teams should be changed at the beginning of each game. The teacher should assure that teams are evenly divided.

4. The teacher should act as judge to assure fairness.

5. A definite time limit should be established.

6. Background information and material may be presented before the game is played by the class. The game should not answer all questions but should stimulate the students to further research.

7. Evaluation of the game should be the final step in its presentation.

ADVANTAGES OF USING GAMES:

1. Students engaging in educational games seem to learn more than students taught by traditional approaches and remember more information over a longer period of time.

2. Gaming is highly motivational. Games motivate students with all ranges of abilities.

3. Games appear to be very valuable in effecting attitude change.

4. Students become involved in interaction with one another.

TYPES OF GAMES:

1. Paper and pencil games, such as puzzles, word finds,

etc. Individuals can work these games at their own speed.

2. Classroom games. The entire class participates in the game. Teams are usually used with these games.

3. Board games. Two to four students participate in this game. Students or teacher may construct the boards used in the game.

DEMONSTRATIONS/EXPERIMENTS

DEMONSTRATIONS are activities that illustrate something that is already known.

EXPERIMENTS are used as a way of learning about or discovering a scientific fact or a concept for the first time. A principle proved through experimentation is more meaningful and will be remembered longer.

Demonstrations/experiments may be done by the teacher, by the teacher with the students, or by the students.

PRELIMINARY REQUIREMENTS:

1. It is usually better that you try the experiment/demonstration before it is used.
2. Make sure that all the equipment necessary for the experiment is available and in good working order.
3. If rules or procedures are necessary, they should be written on the board or on an overhead projector rather than verbalizing them.

DURING THE PROCEDURE:

1. Be sure that all students can either participate or are in a position to see the experiment/demonstration.
2. Inform students what to look for.
3. If students are participating, circulate among the groups for support and questioning.

AFTER THE PROCEDURE:

1. Appoint a clean-up committee, if necessary.
2. The follow-up of an experiment/demonstration should involve a class discussion or report on what has been learned during the procedure. Students should be able to ask questions and/or research further aspects related to the experiment/demonstration.

ADVANTAGES:

1. Illustrates visually a procedure or problem.
2. Offers students an opportunity to participate.
3. Evaluates certain skills.

BRAINSTORMING

Brainstorming is a technique for generating ideas quickly with a group of people. Some of the guidelines for effective brainstorming include:

1. Persons should be arranged in groups of five to six.
2. Each group should be given a large piece of butcher paper and a felt-tipped pen for recording.
3. The group should appoint its own recorder.
4. The teacher/leader will give the groups the subject for brainstorming.
5. All group members should call out ideas; quantity is important rather than quality.
6. No discussion of any idea is allowed during the brainstorming.
7. No evaluation of any remark is permitted, positive or negative, as this would inhibit the free flow of ideas.
8. Persons should be encouraged to "piggy-back" on each other's statements.
9. All ideas are recorded, regardless of how "ridiculous" they may seem.
10. The brainstorming session should be limited to three to six minutes.

AFTER THE ACTIVITY, FOLLOW-UP OR PROCESSING MIGHT INCLUDE:

1. Personal reactions
2. Rank-ordering of best ideas
3. Benefits of the experience
4. An in-depth study of one or more of the better ideas.

ADVANTAGES OF BRAINSTORMING:

1. Provides free expression without threat of criticism
2. Allows for an exchange of ideas
3. Stimulates creativity of participants

FIELD TRIPS

In order to avoid confusion and chaos, it is necessary to plan carefully each step of any field trip that involves students. The success or failure of a trip is in direct ratio to the amount and caliber of this planning. Each field trip, of course, will present its individual problems, however, the following suggestions are basic and applicable in the majority of situations. A general overall outline of field trip planning might be as follows:

A. Establish the purpose

B. List objectives

C. Pre-trip arrangements

D. Enroute

E. Record field observations

F. Plan follow-up activities

G. Equipment

* * *

A. ESTABLISH THE PURPOSE: A field trip is a special kind of learning experience that requires only that the participant uses his five senses for observation -- reading ability, high I.Q., etc. are only aids. It should grow out of the regular learning activities of the pupils and be related to these activities. It must be better than the instructional procedure which it replaces for the time involved in order to justify its existence.

B. LIST OBJECTIVES: The phase of textbook study should be the prime factor in deciding the itinerary of a field trip, whether it be rocks,

minerals, fossils or geological formations, the textbook, in most cases, should set the stage.

Many disciplines should be correlated in the presentations at various stops.

C. PRE-TRIP ARRANGEMENTS:

1. Request permission from your Principal, explaining the purpose, destination, etc.
2. Make dry run checking time enroute, ideas for lecture, viewing, collecting, and picture taking time. Obtain permission from land-owners, foreman, or other persons in charge of area. Make arrangements for guides if possible. Inquire from the local residents about any special sites of interest.
3. Draw up itinerary listing time and location of departure and return, all stops such as lunch, gas, and rest stops.
4. Send form letter home with student stating all necessary information, etc. Arrange a detachable section for parent to sign and return to you absolving any claim against school, sponsors, etc. This section serves as application for the trip and if fee is required it should be submitted at this time.
5. Make arrangements for insurance coverage for students and chaperones.
6. Get maps of the area. (If possible, reproduce for students.)
7. Chaperones for each bus should be contacted well in advance of trip. State duties, allowable conduct, etc.
8. Select alternate date in case of inclement weather.
9. Leave copy of itinerary with school secretary, principal,

or supervisor in case of emergency.

10. Inform driver of intended route, time of departure and return, and if he is to furnish his own lunch.

D. ENROUTE: Review rules on conduct. Request students to select a buddy to sit with and occupy that seat throughout trip. (This eliminates checking roll after each stop.)

On some trips it is impossible, but try to follow the itinerary, making up any loss of time at the least interesting stops. Parents may need to find their child in case of emergency. ALWAYS respect landowners' property. Go through fences, not over, close all gates and do not frighten stock. Leave an area better than you found it whenever possible.

E. RECORD FIELD OBSERVATIONS: What time did you actually arrive, and how much time was wisely spent at each site? Were restroom facilities adequate? Did you gas up where you intended? How about the road conditions, were there any detours to alter your E.T.A.?

Record your observations on film (16mm, 35mm, slides). How about taping sounds or commentary in situ? Record F stops, shutter speed, location of each picture and place identification information on slide holder immediately on return from processor.

F. FOLLOW-UP: Send thank-you notes to those who made the trip possible, i.e. landowners, companies, sponsors, etc.

Discussion of the field trip should be made at the first meeting following the trip. Where would they have enjoyed staying longer or shorter periods of time? You might note this and alter next year's itinerary accordingly.

Display specimens collected.

Did you achieve the aims and objectives for the experience?

A self-evaluation of the trip and perhaps a new itinerary should be drawn up for next year while it is fresh in your mind.

When film returns, show and discuss with class.

G. EQUIPMENT: Equipment may vary due to time of year, terrain to be encountered, length of time of trip, type of collecting, etc. Mark all items.

INDIVIDUAL EQUIPMENT

pick
10x lens
collecting bags
marking pen
pencil and pad
sack lunch
light jacket
camera and binoculars (opt.)
small identification book
suntan lotion
sunglasses

ADDITIONAL EQUIPMENT FOR EXTENDED TRIP

sleeping bag/air mattress
eating tools
personal equipment
wash cloth, towels, soap
flash light, pocket knife
changes of clothes, shoes, socks, etc.
insect repellent

EQUIPMENT SHARED WITH OTHERS

tent
camp kitchen
ice box
stove
lantern

POSTER BOARD TRAY CONSTRUCTION

Size 22.5 x 18 x 4 cm
Cut 4 dividers 26 cm x 3.8 cm
Cut 3 dividers 30.5 cm x 3.8 cm
20-4.5 x 4.5 cm compartments -- can be numbered for identification.

Cut on solid lines
Fold 90° angle on dotted lines
Staple or glue as necessary

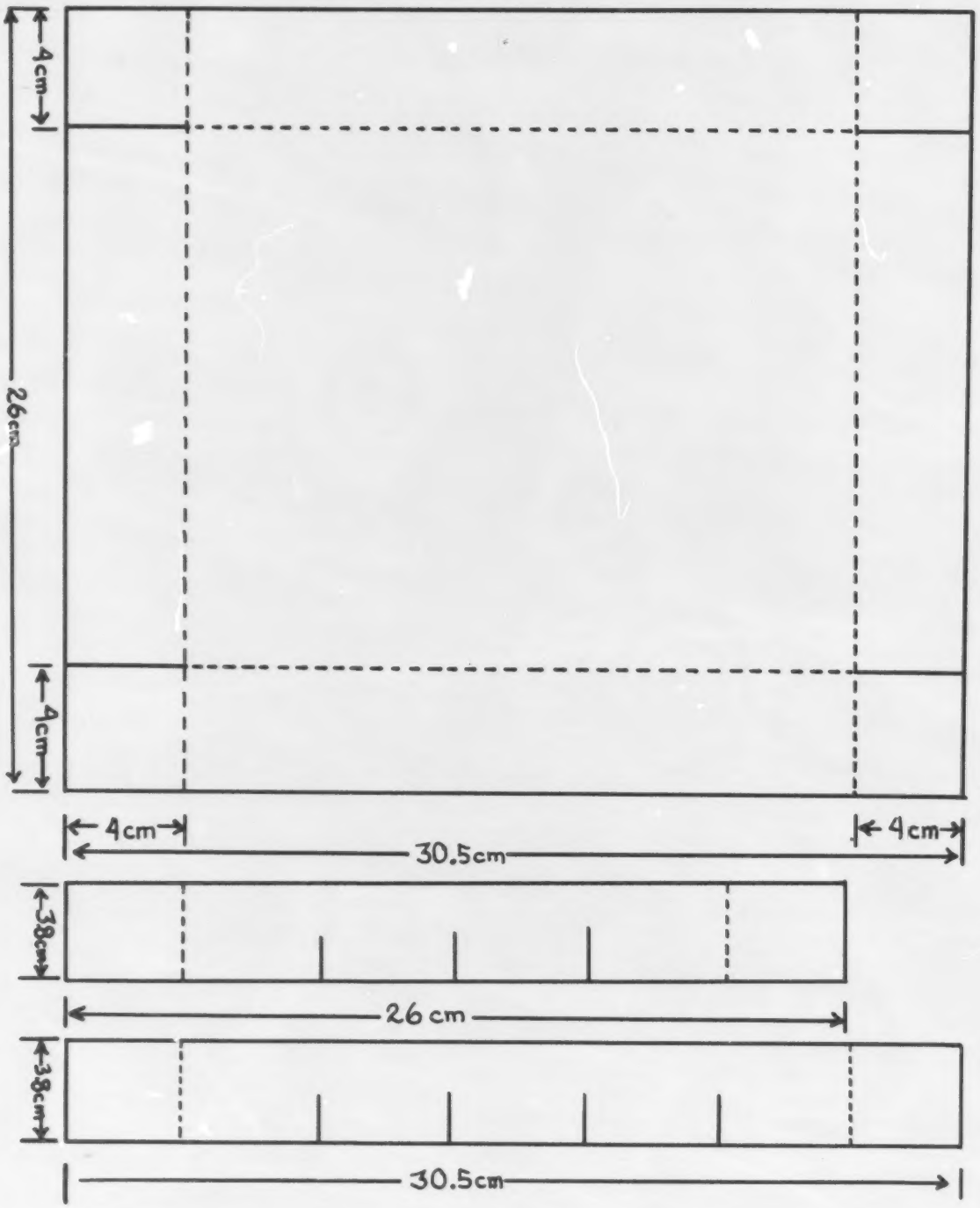

Figure 24

APPENDIX: FILMS

The following films are pertinent to information given in this Outdoor Education Guide and are available from the MEDIA RESOURCE CENTER, STATE DEPARTMENT OF EDUCATION, 2500 NORTH LINCOLN, OKLAHOMA CITY, OK 73105.

FOOD FOR YOUTH-FUEL FOR LIFE

Students might get the idea that calories are the only things the body has to have. But this program shows that calories are only one of the body needs. A whole host of other substances--nutrients--keep the body growing and developing normally. These nutrients, together with calories, help to ensure that children grow and mature physically and mentally into functioning adults. From the Food for Youth Series. USDA

FOOD TO LIVE AND GROW-HABITS OF HEALTH

Students are led to understand the importance of good diet as they watch the growth and behavior of rats fed some of the same foods they have available. BFA

HOW A HAMBURGER TURNS INTO YOU

This film traces protein metabolism from digestion through re-synthesis in the cells. By focusing specifically on proteins the film demonstrates the essential processes that change food nutrients into the molecular building blocks that nourish cells and fuels the activity in the body. Gives a scientific basis for understanding how we grow. PE

I LIKE BIKES, BUT. . .

Shows hazards of bikes blending with cars in traffic. Emphasizes difficulty in seeing bikes, how easily they may be upset and the dangers of inattentive bicyclists. GM

I'M NO FOOL HAVING FUN

Shows what to do and what not to do when having fun hiking, swimming, and skating. From the Safety Series. DISNEY

I'M NO FOOL IN WATER

Emphasizes the importance of learning to swim and of observing common sense rules about when and where to swim. From the Safety Series. DISNEY

I'M NO FOOL WITH A BICYCLE

Jiminy Cricket traces the development of the bicycle and presents specific rules for riding bicycles. From the Safety Series. DISNEY

I'M NO FOOL WITH FIRE

Shows how fire is made, how it serves man and how to use. From the Safety Series. DISNEY

LIFETIME SPORTS IN EDUCATION

Promotes health, physical education, and recreation for all ages. AAHPER

OKLAHOMA DRIVE

Serves as a report about Oklahoma roads, their importance, their conditions, future needs and funding. Scenes from Oklahoma, i.e., buffalo, sawmills, loading steel on the barge canal, Sand Bass Festival. MEYER

TECHNOLOGICAL FAILURES

Illustrates the need for a greater awareness in dealing with the problems that arise from our dependence on modern technology and the conveniences it has brought. From the Your Chance to Live Series. USDCPA

TREASURE HUNT

Helps students explore the process of producing income and helps them discover ways in which they can achieve economic independence by participating in the economic system now and in the future. From the Bread and Butterflies Series. AIT

UNDERSTANDING STRESSES AND STRAINS

Discusses the mental side of the health triangle with emphasis on the pressures and worries of everyday life which can damage health. DISNEY

WATERS RETURNING, THE

Illustrates the water cycle. From the Focus on Active Learning Series. MACM

WHEN THE CIRCUIT BREAKS

Explains that all forms of energy have circuit breakers; when demand exceeds suppy, the circuit breaks; when several circuits break at the same time, we have an energy crisis. Examines the traditional sources of energy, looks at the present to show how demand is steadily gaining on supply, and looks to the future to see what new sources of energy show the greatest promise. Can serve as a springboard for discussion on what each person can do right now to cope with the energy problem.

WONDERING ABOUT THINGS

Presents the varying answers of people from a broad spectrum of creative fields, ranging from a musician to a scientist, reinforced by

visual evidence, concluding that science, wisely used, is an indispensable part of humanity's hope for the future. MTP

YOUR CHANCE TO LIVE-EARTHWATCH

Discusses the "two faces of earth," one tranquil and benign, the other hostile and devastating. Shows various natural and man-made disasters that threaten lives and property. Also introduces the subject of preparedness. From the Your Chance to Live Series. USDCPA

YOUR CHANCE TO LIVE-FLOOD

Presents the story of a canoeist who ignores the obvious in his search for adventure on a flood swollen river. From the Your Chance to Live Series. USDCPA

YOUR CHANCE TO LIVE-FOREST FIRE

A father and his young son are trapped by a forest fire. The film details their escape while outlining the deadly realities of the devastating power of a forest fire. From the Your Chance to Live Series. USDCPA

YOUR CHANCE TO LIVE-HEATWAVE

This film presents a view of what the dangers of excessive heat are, their symptoms, and ways of preparing for and protecting oneself from the heat. Illustrates what can happen to people as they work and play in environments where excessive heat may predominate. From the Your Chance to Live Series. USDCPA

YOUR CHANCE TO LIVE-NUCLEAR DISASTER

Follows the activities of a film company making documentary about nuclear disaster. From the Your Chance to Live Series. USDCPA

YOUR CHANCE TO LIVE-POLLUTION

Presents a surrealistic look at the future if man does not learn to control the problems of pollution. From the Your Chance to Live Series. USDCPA

YOUR CHANCE TO LIVE-TORNADO

Shows the near tragic event of a tornado that traps three young people. Also vividly shows its devastating power on a nearby town. From the Your Chance to Live Series. USDCPA

YOUR CHANCE TO LIVE-WINTERSTORM

Illustrates the dangers of winter storms using the short story by Jack London, "TO BUILD A FIRE," as a vehicle for showing the tragic circum-

stances possible during winter storms. From the Your Chance to Live Series. USDCPA

YOUTH PHYSICAL FITNESS-A REPORT TO THE NATION

Report by the President's Council on Youth Fitness stressing the need for vigorous activity programs in schools. Documentary presentation of how one city, through broad community action involving lay and professional groups, newspaper, radio station and school staff, developed an active fitness program. ELASUS

CAREER DISCOVERIES-PEOPLE WHO WORK IN SCIENCE

Segments stress curiosity, inquiry, precision, devotion to scientific method. From the Career Discoveries Series. GA

CHALLENGE & CHANGE: A STORY OF SCIENCE & TECHNOLOGY

Tells how science developed and how it is related to technology, using the modern metal, aluminum, to illustrate the concepts presented.

CRITICAL ISSUES IN SCIENCE & SOCIETY: THE GREAT ENERGY DEBATE

This program is designed to give students a solid base of information about current and future energy resources; to raise the values issue inherent in any realistic search for a solution to the energy debate; to present some concrete cases for specific discussions.

DO WE LIVE OR EXIST?

Written, photographed, narrated, and scored by students of Woodlands High School, Hartsdale, New York; relates loneliness, human contact, environment and pollution in a response-provoking sight/sound essay. GA

ENERGY CONSERVATION EDUCATION FOR OKLAHOMA DRIVERS

The purpose of this filmstrip is to show how America became so heavily dependent on the automobile as the major means of transportation, and the reliance on huge amounts of gasoline each year. In this filmstrip are tips on how the driver of the automobile can reduce the fuel consumption of the car, regardless of the age, type, or body style. ODE

ENERGY: KEY TO MAN'S GREAT GOALS

This set is designed to provide the upper elementary and junior high students with a comprehensive look at the energy situation. Introduces the six basic forms of energy and explores in depth the possibilities and problems involved in harnessing radiant energy, the history, uses, and future of petroleum; and background and future of coal.

HIGH ON LIFE

Describes ways other than drug use to achieve peace of mind, daily excitment and release. Shows students' personal experiences in being close to nature, creating music, writing, religious involvement, committing their energies to political activities and community service. GA

SMALL WORLDS OF LIFE

Explores ecological communities and complex relationships in a variety of environments. Presents life in a pond, in the coral reef, of the apple tree, in the desert, in the tundra, in the salt marsh, and in the everglades. NG

WHAT IS FOOD?

Reveals the fundamental chemical similarity of all life forms; introduces food chains and the food web; shows how photosynthesis places green plants at the base of all life and how energy fuels every organism. Helps students trace food web interactions culminating in food.

APPENDIX: REFERENCES AND RESOURCES

American Assoc. for the
Advancement of Science
1515 Massachusette Ave., N.W.
Washington, D.C. 20005

American Chemical Society
1155 Sixteenth St., N.W.
Washington, D.C. 20036

American Forestry Assoc.
1319 Eighteenth St., N.W.
Washington, D.C. 20036

American Geological Institute
2201 M Street, N.W.
Washington, D.C. 20007

American Heart Association
National Center
7320 Greenville Ave.
Dallas TX 75231

American Institute of
Biological Sciences
1401 Wilson Blvd.
Arlington, VA 22209

American Museum of
Atomic Energy
Oak Ridge, TN 37830

American Museum of
Science and Energy
Oak Ridge Assoc. Universities
P.O. Box 117
Oak Ridge, TN 37830

American Public Health Assoc.
1740 Broadway
New York, N.Y. 10019

Assoc. of Interpretive
Naturalists
2240 W. Buno Road
Milford, MI 48042

Bergey Windpower Co., Inc.
2001 Priestley Ave.
Norman, OK 73069

Bureau of Mines
4040 N. Lincoln Blvd.
Oklahoma City, Oklahoma 73105

Bureau of Mines
Dept. of Interior
Eighteenth and C St., N.W.
Washington, D.C. 20240

Bureau of Outdoor Recreation
Dept. of Interior
Eighteenth and C St., N.W.
Washington D.C. 20240

Bureau of Reclamation
Dept. of Interior
Eighteenth and C St., N.W.
Washington, D.C. 20240

Cartography Services
Dept. of Geography, Arts
and Science Extension
Oklahoma State University
Stillwater, OK 74074

Chemical Mfg. Assoc.
1825 Connecticut Ave., N.W.
Washington, D.C. 20009

Defenders of Wildlife
2000 N Street, N.W.
Washington, D.C. 20036

Dept. of Energy
Energy Information Admn.
Washington, D.C. 20585

Ecological Society of America
Dept. of Botany
Univ. of North Carolina
Chapel Hill, N.C. 27514

Environmental Action, Inc.
Room 731
1346 Connecticut Ave., N.W.
Washington, D.C. 20036

Geological Survey
Dept. of Interior
Eighteenth and F St., N.W.
Washington, D.C. 20242

Geoscience Information Center
American Geological Institute
2201 M St., N.W.
Washington D.C. 20037
Golden Nature Guides
Golden Press, Inc.
New York, N.Y. 10019

McDonald's Corp.
One McDonald's Plaza
Oak Brook, IL 60521

National Academy of Science
2101 Constitution Ave., N.W.
Washington, D.C. 20418

National Assoc. of Biology
Teachers
1420 N St. N.W.
Washington, D.C. 20005

National Audubon Society
1130 Fifth Ave.
New York, N.Y. 10028

National Education Assoc.
1201 Sixteenth St., N.W.
Washington, D.C. 20036

National Geographic Society
Box 1640
Washington, D.C. 20013

National Parks and
Conservation Assoc.
1701 Eighteenth St. N.W.
Washington, D.C 20009

National Recreation and
Park Assoc.
1700 Pennsylvania Ave., N.W.
Washington, D.C. 20006

National Science Teachers Assoc.
1742 Connecticut Ave., N.W.
Washington, D.C. 20009

National Wildlife Federation
1412 Sixteenth St., N.W.
Washington, D.C. 22201

Office of Ecology
Smithsonian Institute
Tenth St. and Constitution Ave., N.W.
Washington, D.C. 20560

Oklahoma Assoc. of Conservation
Districts
1002 North Wentz
Guthrie, OK 73044

Oklahoma Conservation Commission
20 State Capitol Bldg.
Oklahoma City, OK 73105

Oklahoma Dept. of Agriculture
State Capitol Bldg.
Oklahoma City, OK 73105

Oklahoma Department of Education
Oliver Hodge Bldg.
2500 N. Lincoln
Oklahoma City, OK 73105

Oklahoma Department of Energy
4400 N. Lincoln Blvd.
Oklahoma City, OK 73105

Oklahoma Department of Pollution
Control
Northeast Tenth and Stonewall
Oklahoma City, OK 73105

Oklahoma Department of Tourism
and Recreation
500 Will Rogers Memorial Bldg.
Oklahoma City, OK 73105

Oklahoma Department of Wildlife
Conservation
1801 North Lincoln Blvd.
Oklahoma City, OK 73105

Oklahoma Geological Survey
University of Oklahoma
Norman, OK 73069

Oklahoma State Department of Health
Northeast Tenth and Stonewall
Oklahoma City, OK 73105

Oklahoma Sun Systems, Inc.
207 W. Oklahoma
P. O. Box 128
Okarche, Oklahoma 73762

Outdoor Biology Instructional Strategies
Lawrence Hall of Science
University of California
Berkeley, CA 93305

Soil Conservation Service
U.S. Dept. of Agriculture
Washington, D.C. 20250

Soil Conservation Society of America
7515 Northeast Ankeny Road
Ankeny, IA 50021

Solar Energy Education Project
Curriculum Service, Rm. 314D
State Education Department
Albany, NY 12234

Southern Solar Energy Center
61 Perimeter Park
Atlanta, GA 30341

State Department of Agriculture
Forestry Division
122 State Capitol
Oklahoma City, OK 73105

Tennessee Valley Authority
New Sprankle Bldg.
Knoxville, TN 37902

U.S. Environmental Protection Agency
Region 6
1201 Elm St.
Dallas, TX 75270

U.S. Geological Survey
Water Resources Division
201 N.W. Third St., Room 621
Oklahoma City, OK 73102

Water Pollution Control Federation
3900 Wisconsin Ave., N.W.
Washington, D.C. 20016

WATTS
The State Education Department
Albany, N.Y. 12234

Whittier School of Out of Doors
2000 West Brooks
Norman, OK 73069

Wilderness Society
729 Fifteenth St., N.W.
Washington, D.C. 20005

The Wildlife Society
Suite 611
7101 Wisconsin Ave., N.W.
Washington, D.C. 20016

World Wildlife Fund
Suite 728
910 Seventeenth St.
Washington, D.C. 20006

Zero Population Growth
4080 Fabian Way
Palo Alto, CA 94303

BIBLIOGRAPHY

A Guide to the Study of Environmental Pollution, W. A. Andrews, Prentice Hall, 1972 - Where is Everybody?, Particulate Matter In the Air, Ecosystem in a Jar.

A Guide to the Study of Freshwater Ecology, Prentice Hall, 1972 - Microcommunity in Pond Water.

Common Minerals, Rocks, and Fossils of Oklahoma; W. E. Ham and Neville M. Artis, Jr. - Geological Survey Guidebook.

Critters and Concepts, A Teaching Guide to Oklahoma Wildlife, Oklahoma Department of Wildlife, 1979 - Aluminum Can Drive, Oklahoma's Habitats Part I and Part II, Saturated Habitat, Big Problems Come in Small Packages, Meeting Tomorrow's Needs Today, Space Ship Earth Terrarium, Paper Capers, You, Us, and Electricity, There's a Hole In the Bucket!

Earth Science: An Activity-Centered Program; Bishop and Lewis, Charles E. Merrill Publishing Co., 1976.

Fossils, A Guide to Prehistoric Life; Rhodes, Zim, and Shaffer - The Golden Nature Guide Series, Golden Press, Inc., New York, N.Y. 10019.

Geology and Earth Resources of Oklahoma, Johnson, Dr. Kenneth S., Oklahoma Geological Survey, University of Oklahoma, Norman, OK 73069 - Maps: Mineral Resources of Oklahoma, Generalized Oil and Gas Maps of Oklahoma.

Geology Science and Profession, American Geological Institute, 2201 M Street, N.W., Washington, E.C. 20007 - Oilfield Collage.

Investigations in Ecology, Schultz and Marcuccio, Charles E. Merrill Publishing Co., 1972 - Find a Leaky Faucet at Home or at School.

Investigating the Earth, American Geological Institute, Falls Church, VA 22041 - When Did Man Arrive.

Oklahoma in Maps, Atlas Project, Cartography Service, Department of Geography, Oklahoma State University, Stillwater, OK 74074 - Maps: Physiographic Map of Oklahoma, Topographic Map of Oklahoma, Major Geologic Provinces of Oklahoma, Percent of Forest Land by County.

Outdoor Biology Instructional Strategies, Lawrence Hall of Science, University of California, Berkeley, CA 93305 - Mapping a Study Site, Animal Diversity, Terrestrial High-Low Hunt, Silent Stalking, Plant Hunt, Invent an Animal, Population Game, Out of Control.

People and Their Environment, M.J. Brennan, J.G. Ferguson Publishing Co., 1973 - The Sky is Falling.

Putting Your Heart Into the Curriculum, American Heart Association, National Center, 7320 Greenville Ave., Dallas, TX 75231 - Teacher Aids.

Science Activities in Energy Conservation, The American Museum of Atomic Energy, Oak Ridge, TN 37830 - Heat Retention.

Teacher's Curriculum Guide for Full Ecology, Center for Environmental Education, Brevard County School System, Cocoa, Florida 32922 - Eco-Community Relationships.

Teachers Resources Booklet, Project ECO, Ames Community Schools, Ames, IA 50010 - Creating Natural Prints Through a Dry Photographic Process.

Urban Studies, Prentice Hall, 1976 - Carpooling Monitor System.

Whittier School of Out of Doors, 2000 West Brooks, Norman, OK 73069 - Sun Prints.

APPENDIX: EVALUATION SHEET

TO: Middle School and Junior High Teachers

The State Department of Education would appreciate your help. Please answer the following questions and return this page to the address given below:

Did you find this Outdoor Education Guide helpful in your classes? ___yes ___no

Which chapters did you use? __1 __2 __3 __4 __5

With regard to the activities, did you use: ___all ___some ___none

Do you feel the materials in this book are suitable for middle school classes? ___yes ___no

Do you feel the need for additional training in outdoor education? ___yes ___no

Would you be interested in:

- A two day workshop (weekend) ___yes ___no
- A one week workshop ___yes ___no
- A one day in-service workshop ___yes ___no
- Receiving additional teaching aids from the SDE ___yes ___no

Other (please specify) _____

COMMENTS:

MAIL TO:

Science Specialist
State Department of Education
Oliver Hodge Bldg.
2500 N. Lincoln Blvd.
Oklahoma City, OK 73105